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CANTERBURY COLLEGE

(UNIVERSITY OF NEW ZEALAND)

RECORDS

OF THE

CANTERBURY MUSEUM

VOL. II.

Canterbury Museum

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Curator

CHRISTCHURCH, NEW ZEALAND

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National Museum

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EDGAR R. WAITE, F.L.S., Curator

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FISHES of the GENUS *TRIPTERYGION* and RELATED GENERA in NEW ZEALAND

By Edgar R. Waite, F.L.S., Curator.

Plates I.—V.

With a view to arriving at a better knowledge of the New Zealand species of the Blennioid genus *Tripterygion*, I have collected specimens of this and other genera from various localities, chiefly from rock pools, worked at low tide. Toll was taken from the following districts, namely:—Kaikoura, Lyttelton (Sumner and Taylor's Mistake), Akaroa, Chatham Islands, Auckland Islands, and the Snares. Mr. Henry Suter sent me specimens from Great Barrier Island, Hauraki Gulf, and I have examined the few examples which the Museum furnished.

I have not yet seen specimens from Westland, whence Clarke obtained the material upon which he founded his three nominal species. With the possible exception of *T. dorsale*, which I have associated with *T. medium*, there can be no doubt that they are correctly ascribed to the species under which name they respectively stand in the following pages.

Ten nominal species have appeared in our literature, but in 1904 Hutton[1] accepted only seven of these as valid, namely:—"*T. tripinne* Forster, *T. decemdigitatum* Clarke, *T. medium* Günther, *T. dorsale* Clarke, *T. varium* Forster, *T. nigripenne* Cuvier and Valenciennes, and *T. robustum* Clarke." I find that all specimens seen by me may be referred to one of three species, namely, *T. tripenne*, *T. medium*, and *T. varium*, all of which are well characterised by structural details. The colouration of the last-named is, however, so diversified that it is only by examination of a large series that a just idea can be formed; for example, specimens from the Chatham Islands have quite a

(1) Hutton, Index Faunæ Novæ Zealandiæ, 1904, p. 46.

different colour scheme from those of our South Island shores, yet, apart from this colour character, no difference can be observed.

I had hoped to study the whole of our fishes of the family *Blenniidæ,* but have hitherto been unable to obtain specimens of some forms, and an appeal to Mr. Hamilton,[2] Director of the Dominion Museum, Wellington, where the types of *Stichærium rubrum* and *Auchenopterus aysoni,* were believed to be, reveals the fact that they are now non-existent. While, therefore, dealing with the members of the genera *Tripterygion, Notoclinus,* and *Ericentrus* at some length I have had to be content, for the present, with a mere notice of *Auchenopterus* and *Cologrammus* as culled from the original descriptions and figures, which are, however, not wholly satisfactory.

Key to the Genera.

a. Three dorsal fins.

b. Spines of the first dorsal increase in height backwards, Second dorsal longer than the third

Tripterygion

bb. Spines of the first dorsal decrease in height backwards, Second dorsal shorter than the third

Notoclinus

aa. Two dorsal fins.

c. First dorsal higher than anterior spines of second dorsal, caudal pedunculate.

d. Dorsal with 3 to 8 rays posteriorly

Cristiceps

---

(2) Mr. Hamilton died at Russell, Bay of Islands, 12th Oct., 1913. Widely known as a prolific writer on the Maori and his art, Mr. Hamilton also wrote on biological subjects, including fishes, his best known contribution to the subject being: "List of papers on New Zealand Fishes and Fishing" (T.N.Z.I., xxxiv. 1902, pp. 539-548).

dd. Dorsals composed of spines only or with but a single soft ray

Auchenopterus

cc. Dorsals of uniform height with only a single soft ray, caudal not pedunculate

Ericentrus

aaa. One dorsal fin.

e. Dorsal with six soft rays

Cologrammus

TRIPTERYGION Risso, 1826.

Body robust, covered with ciliate scales of moderate size; lateral line incomplete or interrupted. Head naked. Dorsal fin of three distinct portions, which may be connected at their bases, the first ascendant of 3 to 6 spines, the spines of the second fin more numerous than the rays of the third. Anal fin longer than the second dorsal. Pectoral fin long, the lower rays simple and thickened. Ventrals jugular. Caudal rounded.

a. Head pointed, lateral line extends to below the third dorsal

tripenne

aa. Head rounded, lateral line terminates under the second dorsal.

b. First dorsal of four spines, the lateral line falls to the mid line of the body

medium

bb. First dorsal of five or six spines, the lateral line follows the dorsal contour

varium

Tripterygion tripenne Forster.

Blennius tripennis Forster, in Bloch & Schneider, Syst. Ichth. 1801, p. 174, and Descr. Anim. 1844, p. 125.

Tripterygion forsteri Cuvier and Valenciennes, Hist. Nat. Poiss. xi., 1836, p. 415.

Tripterygium forsteri Günther, Cat. Fish. Brit. Mus. iii., 1861, p. 278.

Trypterygium forsteri Hutton, Cat. Fish. N.Z. 1872, p. 31.

Trypterygium tripennis Hutton, T.N.Z.I. ix. 1877, p. 354.

Trypterigium decemdigitatus Clarke, T.N.Z.I. xi., 1879, p. 292. pl. xv.

Plate I.

B. vi.; D. iii. xix. 14; A. 27; V. 2; P. 17; C. 13; Sc. 44; L. lat. 34; L. tr. 8 + 16.

Length of head 3·95; height of body 4·46 and length of caudal 4·65 in the length; diameter of eye 4·0; length of snout 3·45, and interorbital space 6·6 in the length of the head.

The head is sub-acute, nearly flat above, the profile of the snout very low, interorbital space flat, eyes close together directed obliquely upwards and cutting the upper profile, a comb-like tentacle with ten teeth above the hinder angle of the orbit; jaws equal; the maxilla extends to beneath the first third of the eye. The posterior nostril is close to the upper angle of the eye and the anterior one is midway between it and the upper lip, it has a tentacle with four branches.

Teeth.—A very broad band of teeth in the jaws, teeth also on the vomer and palatines; a broad frenum behind the upper teeth.

Fins.—The first spine arises over the edge of the preopercle, the others are progressively higher, the third being equal to the length of the snout and eye together; the second fin begins behind the root of the pectoral, and the third midway between the head and the end of the caudal; the highest rays of these fins are sub-equal, and are as high as the body at the insertion of the third fin. The anal commences beneath the eighth spine of the second dorsal and terminates evenly with the last ray. The pectoral is evenly pointed, the tips of its lower rays being free. The ventrals arise close together and the inner ray is the longer, equal to the post-nasal length of the head. The caudal is well rounded and its peduncle is deep, equal to one-half the height of the body.

Scales.—Head, and space in front of the ventrals naked, the whole body, including a narrow space in front of the dorsal fin and the base of the pectoral, clothed with large finely ciliated scales, those on the back, chest, and belly very small. The lateral

line commences at the opercular angle, rises very slightly over the pectoral, and follows the dorsal profile to below the fifth last dorsal ray, the thirty-four scales thus embraced are tubular, two series of scales below, the line is continued along about six non-tubular scales to the caudal.

Colours.—Head and body deep blue black, scarcely lighter beneath, but brown on the chest, ventrals pale grey; all the other fins black; the anal edged with grey.

Length.—96 mm.

Hab.—Hauraki Gulf, Auckland, Otago, Dusky Sound, West Coast, S.I.

Distinguishing features of *T. tripenne* are the low pointed head, the high fins, of which the first dorsal is formed of three spines only, the multifid tentacle over the eye, the long lateral line, following the dorsal contour, and the dark and, generally, uniform colouration.

The description is drawn up from one of two specimens sent to me by Mr. H. Suter, from Hauraki Gulf. They do not exhibit trace of the spot at the base of the pectoral, described by Forster, but a series of specimens would no doubt show many variations in colour and markings.

Tripterygion medium Günther.

Tripterygium medium Günther, Cat. Fish. Brit. Mus. iii., 1861, p. 278.

Trypterygium medium Hutton, Cat. Fish N.Z. 1872, p. 32.

Trypterigium dorsalis Clarke, T.N.Z.I. xi. 1879, p. 291, pl. xv.

Plate II.

B. vi.; D. iv. xvii. 12; A. 22; P. 15; V. 2; C. 12 + 2; Sc. 61; L. lat. 21, L. tr. 10 + 7.

Length of head 3·45; height of body 4·15, and length of caudal 4·0 in the length; diameter of eye 5·1; length of snout 4·0, and interorbital space 6·8 in the length of the head.

The head is nearly flat above, the profile of the snout very steep, eyes close together directed obliquely upwards, interorbital space slightly concave; upper jaw slightly the longer; the maxillary reaches to nearly below the middle of the eye; posterior nostril immediately in front of the middle of the eye,

anterior nostril midway between it and the upper edge of the lip, it is furnished with a bifid tentacle; no tentacle over the eye.

Teeth.—A single series of sharp teeth in the jaws followed by a band of minute teeth, a broad frenum behind the upper teeth.

Fins.—The first spine, whose length is equal to the diameter of the eye, arises over the edge of the preopercle, the others rise regularly to the fourth, which is twice the height of the first. The second fin begins behind the root of the pectoral and the third midway between the head and the end of the caudal; though higher than the first, the second and third fin rays are comparatively low, the highest rays being less than the body at the origin of the third dorsal. The anal commences beneath the ninth spine of the second dorsal and terminates posteriorly to the last dorsal ray. The pectoral is rounded, the tips of its lower rays being free. The inner ray of the ventral is the longer, its length being equal to the distance between the anterior nostril and the opercular margin. The caudal is rounded and the peduncle narrow, its height being less than one-third that of the body.

Scales.—Head, throat, chest and a space on each side of the spinous dorsals and of the anal fin naked; the scales are small and finely ciliated. The lateral line arises well above the origin of the pectoral, and passes downwards with the concavity above, to the mid-line of the body, terminating below the base of the fifth last spine of the second dorsal fin; about two scales exceeding the reach of the pectoral. The lateral line is very pronounced, and in some specimens may be continued to the caudal.

Colours.—Reddish brown above and grey beneath, head brown with irregular darker blotches; body with six black blotches across the back, one at the commencement of each of the three fins, one below the middle of the second and third fins respectively, and one on the caudal peduncle; a zigzag runs along the mid line of the body, a blue spot in each lower wave; upper half of first dorsal black, about five rows of dark spots on the second and third fins, pectoral with seven and caudal with ten bars, anal grey barred and tipped with white, ventrals white.

Length.—85·2 mm.

Hab.—Great Barrier Is., Wellington, Kaikoura, Lyttelton, Hokitika.

This species may be readily detected by the contour of the lateral line, which is concave above, by the absence of an orbital tentacle, and by the body markings. The spines of the first

dorsal fin appear to be constantly four in number,[3] but other variations are indicated below:—

D. iv. xv.-xvii. 11-13. A. 20-25.

T. dorsale Clarke, from Hokitika, on the west coast of the South Island, differs from typical examples only by the circumstance that the lateral line extends to the base of the caudal rays, and I have a specimen from Canterbury which exhibits this feature. The author describes the nostril as being single, very minute, and close below the eye. The eastern specimen has the usual double nostril, as shown in the drawing, and the ventral rays are neither short nor extremely fleshy as described and figured by Clarke. The difference in comparative dimensions may be explained by the fact that the author included the caudal in computing the relative lengths of the fish.

The illustrations which accompany the late Mr. F. E. Clarke's papers are not very satisfactory, and would lead one to think that the originals were crude. I have recently had the opportunity of examining some of these, and in justice to Mr. Clarke's memory I should like to say that they were very carefully prepared, and quite satisfactory as originals, but were evidently executed without a knowledge of the limitations of the reproductive process, at any rate as exemplified by the workers responsible for those particular reproductions.

Tripterygion varium Forster.

Blennius varius Forster, in Bloch and Schneider, Syst. Ichth. 1801, p. 178, and Descr. Anim. 1844, p. 127.

Tripterygion varium Cuvier and Valenciennes, Hist. Nat. Poiss. xi. 1836, p. 414. Waite, Pisces, Sub-ant. Is. N.Z., ii. 1909, p. 597.

Tripterygion nigripenne Cuvier and Valenciennes, *loc. cit.* p. 413, pl. cccxxxix.

Tripterygion capito Jenyns, Fishes Voy. "Beagle," 1841, p. 94; pl. xix. fig. 1.

Tripterygium varium Günther, Cat. Fish. Brit. Mus. iii. 1861. p. 277. Hutton, Cat. Fish. N.Z. 1872, p. 33.

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(3) Günther writes:—"D. 4(5)" I have examined a large number of specimens but in none found five spines.

Tripterygium nigripinne Günther, *loc. cit.*, p. 277. Hutton, *loc. cit.* p. 31, and T.N.Z.I. v. 1873, p. 263, and ix. 1877, p. 354.

Trypterygium forsteri Hutton, T.N.Z.I. v. 1873, p. 263.

Tryterygium fenestratum Hutton, T.N.Z.I. v. 1873, p. 263.

Trypterigium robustum Clarke, T.N.Z.I. xi. 1879, p. 292, pl. xv.

Tripterygium jenningsi Hutton, T.N.Z.I. xi. 1879, p. 339.

Plate III.

B. vi.; D. v.-vi., xx. 12; A. 25; P. 17; V. 2; C. 11. L. lat. 24; L. tr. 8 + 16.

Length of head 3·9, height of body 4·0, and length of caudal 4·6 in the length; diameter of eye 3·8, and interorbital space 8·0 in the head.

The head is flat above with the profile of the snout very steep, interorbital space flat, eyes not close together, directed outwards, the orbits free from the upper profile; jaws equal, the maxilla extends to nearly below the middle of the eye. Posterior nostril in front of the upper angle of the eye, the anterior one midway between it and the upper lip, with a simple tentacle; a bifid tentacle over each eye.

Teeth.—The teeth are pointed, in a single series in each jaw, followed by a broad band; similar teeth on the palatines and vomer: a frenum behind the upper teeth.

Fins.—The first dorsal fin commences over the edge of the preopercle, the second behind the root of the pectoral, and the third at a point much nearer the end of the caudal than the opercular border; the first spine is a little longer than the diameter of the eye, the following rise regularly to the fifth (or sixth) which is one half longer than the first; the highest spines of the second fin are one-half higher than the fifth (or sixth) spine and the anterior rays of the third fin are still higher. The anal arises below the seventh spine of the second dorsal and its rays terminate evenly with those of the third dorsal. The pectoral is evenly pointed and extends to a point equal to its distance from the head. The ventrals are rather short, the inner or longest ray being equal to the length of the head, less the snout. The caudal is rounded and its peduncle rather low, its height rather more than half that of the body at the insertion of the third dorsal fin.

Scales.—Head, to the commencement of the dorsal fin, throat and chest naked, the rest of the body clothed with small finely ciliated scales. The lateral line follows the curve of the back, terminating under the fourth last ray of the second dorsal fin, about seven scales exceeding the reach of the pectoral. Two scales below, it is continued to the caudal.

Colours.—Ground colour variable, Green, olive, brown, orange, or reddish with dark markings, six more or less ring-like figures above the lateral line, fins black, grey, or red, edge of first dorsal black, second and third dorsals with markings at the base to correspond with the rings on the body, anal with a dark sub-marginal band; caudal sometimes spotted. One specimen collected at the Chatham Islands has a wholly black head and a dark line along each side of the spinous dorsal fins.

Length.—85 mm.

Hab.—Wellington, Kaikoura, Lyttelton, Akaroa, Jackson's Bay, Westland, Chatham and Auckland Islands, and the Snares.

T. varium may be distinguished by the larger number of spines, (v.-vi.) in the first dorsal fin, by the bifid tentacle over the eye, and the course of the lateral line, which follows the dorsal contour to near the termination of the second fin.

This is quite the commonest of the three species, at least, on the east coast of the South Island, and is the subject of the greatest number of synonyms.

NOTOCLINUS Gill, 1893.

Differs from *Tripterygion* in having the spines of the first dorsal fin descendant, and the second fin not longer than the third. Pectoral rays less numerous and wholly undivided.

Notoclinus fenestratus Forster.

Blennius fenestratus Forster, in Bloch and Schneider Syst. Ichth. 1801, p. 173, and Descript. Anim. 1844, p. 124.

Tripterygion fenestratum Cuvier and Valenciennes, Hist. Nat. Poiss. xi. 1836, p. 416.

Tripterygium fenestratum Günther, Cat. Fish. Brit. Mus. iii. 1861, p. 278. Hutton, T.N.Z.I. ix. 1877, p. 354.

Trypterygium compressum Hutton, Cat. Fish. N.Z. 1872, p. 32, and T.N.Z.I. v. 1873, p. 263, pl. xv. Arthur T.N.Z.I. xvii. 1885, p. 168, pl. xiv., fig. 6.

Auchenopterus compressus Hutton, T.N.Z.I. viii. 1876, p. 214.

Auchenopterus fenestratus Hutton, T.N.Z.I. xxii. 1890, p. 281.

Notoclinus fenestratus Gill, Mem. Nat. Acad. Sci., vi. 1893, pp. 119, 124.

Plate IV.

D. iv. xi. 13; A. 24; V. 2; P. 11; C. 11; Sc. 43; L. lat. 16 + 29; L. tr. 20.

Length of head 3·18; height of body 4·32; and length of caudal 3·27 in the length; diameter of eye 4·75; length of snout 3·45 and interorbital space 8·4 in the length of the head.

The head is obtuse with a low profile, eyes well separated, lateral, a spoon-like tentacle over the hinder angle of the orbit and a smaller one at the anterior nostril, interorbital space slightly convex, jaws equal, mouth large, the maxillary extending to beyond the hinder edge of the eye, gills four, a slit behind the fourth. Posterior nostril close to the front edge of the eye, the anterior nostril a short distance in advance of it. Body, robust, compressed.

Teeth.—A broad band in each jaw and at the head of the vomer, teeth present also on the palatines.

Fins.—The first dorsal fin stands wholly apart from the second, and its anterior spine is placed immediately behind the eye, it is very long being nearly equal to the depth of the head; the following spines rapidly decrease to the fourth, which is not longer than the diameter of the eye; the second fin commences behind the opercular edge and its base is equal to that of the soft dorsal, which originates midway between the opercle and the base of the caudal rays. The anal arises beneath the fifth spine of the second dorsal and is coterminal with the soft fin. The pectoral rays are comparatively few in number and all are simple. The inner ventral ray is equal to half the length of the head. The caudal is large and rounded and its peduncle is equal to its length behind the anal fin.

Colour.—In preservative the general colour is orange,[4] the head is mottled with grey and brown and has two dark bars above in sequence with those on the body. The body is adorned with

(4) Prof. Benham tells me that specimens kept in aquaria at the Portobello fish hatchery are reddish-orange in colour, so that no great change takes place under preservation as in *Cristiceps* and *Ericentrus*, which in life are of greenish hues.

seven oblique bars, inclined backwards below, all the bars are more or less incomplete below, and the two posterior ones are broken up. Three bars originate each beneath the second and third dorsal fins and the seventh is on the caudal peduncle. The fins are grey, those of the dorsal having clear spaces in the membrane, there are three faint bars on the caudal rays.

Length.—121 mm.

Hab.—Otago.

CRISTICEPS Cuvier and Valenciennes, 1836.

Body moderately elongate, covered with small or rudimentary scales. Two dorsal fins, the first of three descendant spines the second long with a small number (3-8) of posterior soft rays. Lateral line complete, strongly curved anteriorly. Caudal pedunculate.

Cristiceps australis Cuvier and Valenciennes.

Cristiceps australis Cuvier and Valenciennes, Hist. Nat. Poiss. xi., 1836, p. 402, pl. cccxxxvi. Hutton, T.N.Z.I. v., 1873, p. 264.

Cristiceps macleayi Castlenau P.L.S., N.S.W. iii. 1879, p. 385.

Cristiceps howittii Castelnau P.Z.S., Vict. ii. 1873, p. 48.

Cristiceps pallidus, Macleay, P.L.S., N.S.W. vi. 1881, p. 26.

? *Cristiceps splendens* Castelnau, P.Z.S., Vict. ii. 1873, p. 66.

The Australian members of the genus have been recently studied by McCulloch[5] from whom the above synonomy and the following description of *C. australis* is accepted.

D. iii., xxvi.-xxix.; 6-8. A. ii., 24-26. V. 3. Vert. 14 + 30. First dorsal spine situated rather behind the middle of the eye. The two dorsals either entirely separate, or the first just connected to the base of the second by membrane. The dorsal rays equidistant. Caudal peduncle long and slender, the membrane from the last dorsal ray reaching from half to two-thirds along its length. A branched tentacle on the snout and a long simple one over the eye. Snout sub-conical.

Colour.—General colour green with darker bands and silvery markings.

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(5) McCulloch, Rec. Aust. Mus. vii. 1908, p. 39, pl. x. fig. 3.

Hutton rendered the New Zealand localities as Bay of Islands and Cape Campbell, and there are specimens in the Auckland Museum from Hauraki Gulf.

Beyond New Zealand the species occurs in Australia and Tasmania.

AUCHENOPTERUS Günther 1861.

Differs from *Cristiceps* in having larger scales and none or but one soft ray in the dorsal fin.

Auchenopterus aysoni Hector.

Auchenopterus aysoni Hector, T.N.Z.I. xxxiv. 1902, p. 240. pl. xv.

B. iv.; D. iii. 33; A. 10; P. 8; V. 3; L. lat. 22-3-5 (interrupted).

Length of head 4·1; height of body 4·8 in the total; length of snout 3·9 and diameter of eye 8·7 in the head.

Body compressed, scales very minute; a pair of branched tentacles from above the snout, not from the nostril. Gill-openings wide, teeth minute on jaws and vomer; tail slightly unsymmetrical and caudal distinctly separate from both dorsal and caudal.

Colour.—Uniform light brown, with four oval translucent spots on the dorsal fin.

Length.—143 mm.

Hab.—Bay of Islands.

The above description is in part copied and in part deduced from the figures supplied by Hector. I have not seen a specimen of the species, and Mr. Hamilton tells me that the type, supposed to be in the Dominion Museum, no longer exists.

It may be noted that the description and the figure are far from agreeing; the dorsal is illustrated as having three more components than described, while the anal, said to have ten rays is shown as possessing twenty-one, with a gap equal to, at least four rays; the figure is probably more nearly correct. The illustration shows more pectoral rays than described, and ten rays are drawn in the caudal. The tentacle at the tip of the snout is shown, also a simple one over the eye, but the latter is not referred to.

Several points in the description taken in conjunction with the fact that the scales are very minute and the lateral line interrupted, lead to the opinion that the fish is incorrectly assigned to the genus *Auchenopterus*, but actual specimens are requisite before any pronouncement can be made.

This species differs from *A. monophthalmus* Günther, the type of the genus, in having the first dorsal fin entirely separate from and higher than the succeeding portion, a condition which Jordan and Evermann[6] have expressed in the sub-generic name *Corallicola*.

ERICENTRUS Gill, 1893.

Head and mouth small, body elongate, covered with small scales. Two dorsal fins not entirely separate, the second very long with a single posterior soft ray. Anal with two spines. Pectoral with undivided rays. Anterior portion of lateral line curved, composed of distinct scales.

Ericentrus rubrus Hutton.

Stichærium rubrum Hutton, Cat. Fish. N.Z. 1872, p. 33.

Clinus rubrus Hutton, T.N.Z.I. v. 1873, p. 264, pl. ix.

Ericentrus rubrus Gill, Mem. Nat. Acad. Sci. vi. 1893, pp. 119 and 123.

Plate V.

B. vi.; D. iv. xxxvi. 1; A. ii. 24, P. 12; V. 2; C. 12. L. lat. 25.

Length of head 5·23; height of body 4·0, and length of caudal 4·8 in the length; diameter of eye 3·2, length of snout 2·6, and interorbital space 6·5 in the length of the head.

Head small, slightly compressed, upper and lower profiles forming an acute angle, snout pointed, eyes large, occupying half the depth of the head and cutting the upper profile, a bifid tentacle above the middle of the orbit, interorbital space narrow and flat; jaws equal, the maxilla is rounded behind, not dilated, and extends to beneath the first third of the eye; gills four, a slit behind the fourth; gill-rakers small, about ten on the first arch. Posterior nostril above the front edge of the orbit, the anterior one midway between it and the end of the snout, furnished with a tentacle.

(6) Jordan and Evermann, Bull. U.S. Nat. Mus. iii. 1898, p. 2369.

Teeth.—A broad patch in each jaw and on the vomer, a frenum behind the upper teeth.

Fins.—The dorsal fin arises slightly in advance of the edge of the preopercle and its anterior spines are but little longer than the diameter of the eye, there is a notch behind the fourth (or fifth) spine and another, less marked, behind the twenty-seventh of the whole series, the spines of this third portion are slightly higher than the preceding ones, the fin is terminated by a single small ray. The anal commences beneath the twelfth spine of the second dorsal, two spines being followed by twenty-four simple rays. The pectoral is small, rounded, and composed of undivided rays. The ventrals are inserted in advance of the pectorals. The caudal is rounded of undivided rays and its peduncle is narrow, one-third greater than the diameter of the eye, the last rays of both dorsal and anal fins are attached to it by membrane.

Scales.—The entire head is naked, but the body is wholly clothed with small embedded scales; the lateral line arises above the edge of the preopercle and drops abruptly to the midline behind the pectoral, whence it passes, on less defined scales in a more or less broken series, to the caudal.

Colour.—In life the ground colour is a seaweed green with dark markings disposed as below:—A series of elongate spots close to and parallel to the dorsal profile, another series on the lateral line and usually some smaller spots below it; a dark mark behind and another below the eye; both dorsal and anal fins have oblique markings in contrary direction to the lie of the spines or rays. A few indistinct bars cross the tail.

Length.—82 mm.

Hab.—Wellington, Kaikoura, Akaroa, Chatham Is.

This species is not very common, but I have taken it in rock pools at Kaikoura and Akaroa, also at the Chatham Islands, while the type specimens were obtained in Wellington Harbour.

Hiding under weeds in the pools, the little fishes are scarcely to be found unless the water is poisoned, when they leave their retreats in common with other denizens of the pool.

So well do the colour and markings of the fish harmonise with its surroundings that even when well within view it cannot be detected until it moves, when it may be netted with a sweep of the hand-net. When transferred to preservatives, either alcohol or formaline, its colour is completely changed, the brilliant green becoming an equally brilliant red, afterwards changing to orange. This disposition to change colour is responsible for the

inappropriate name *rubrus,* which refers to the appearance of the fish after preservation.

Hutton states that the dorsal commences immediately at the back of the head, whereas its origin is in advance of the preopercle. Many of the females obtained were distended with young, showing ovoviviparity, a character as far as known, of the *Clininæ.*

COLOGRAMMUS Gill, 1893.

"The *Stichærium flavescens* or *Clinus flavescens* of Hutton is differentiated from other types (and especially *Ericentrus*) by the form, more nearly even dorsal with a short-rayed portion (about 38 spines + 6 rays), and imperfect lateral line; it may appropriately be designated as *Cologrammus.*"—(Gill.)

Cologrammus flavescens Hutton.

Stichærium flavescens Hutton, Cat. Fish. N.Z. 1872, p. 33.
Clinus flavescens Hutton, T.N.Z.I. v. 1873, p. 264, pl. xv.
Cologrammus flavescens Gill, Mem. Nat. Acad. Sci. vi. 1893, pp. 119 and 124.

B. vi. D. xxxviii. 6; A. 30; V. 3; P. 12; C. 12.

Length of head 4·6 and height of body 5·25 in the length. Snout slightly shorter than the diameter of the eye, which is 4·33 in the head. The snout is rounded and the dorsal fin commences at a very short distance behind the head; the lateral line slopes gently downwards, ceasing under the tenth dorsal spine; dorsal joined to the base of the caudal by a membrane.

Colour.—Pale yellow, with two oblique reddish streaks on the preoperculum from the eye backwards.

Hab.—Cook Strait.

As, according to Mr. Hamilton, the type specimen is no longer to be found in the Dominion Museum, and as no other example is known in collections, I have virtually reproduced Hutton's description. This, taken in conjunction with the later published figure, which appears to be only fairly reliable, should render it easy to identify the species when again obtained.

The following discrepancies occur between the description and the figure:—The dorsal fin is represented as arising behind the preopercle, but described as commencing behind the head.

Two ventral rays only are shown, while the lateral line is drawn as continuous, instead of terminating beneath the tenth dorsal spine.

EXPLANATION OF PLATES.

Plate I.

Tripterygion tripenne Forster.

Nearly twice natural size.

Plate II.

Tripterygion medium Günther.

Twice natural size.

Plate III.

Tripterygion varium Forster.

Twice natural size.

Plate IV.

Notoclinus fenestratus Forster.

One-third larger than natural size.

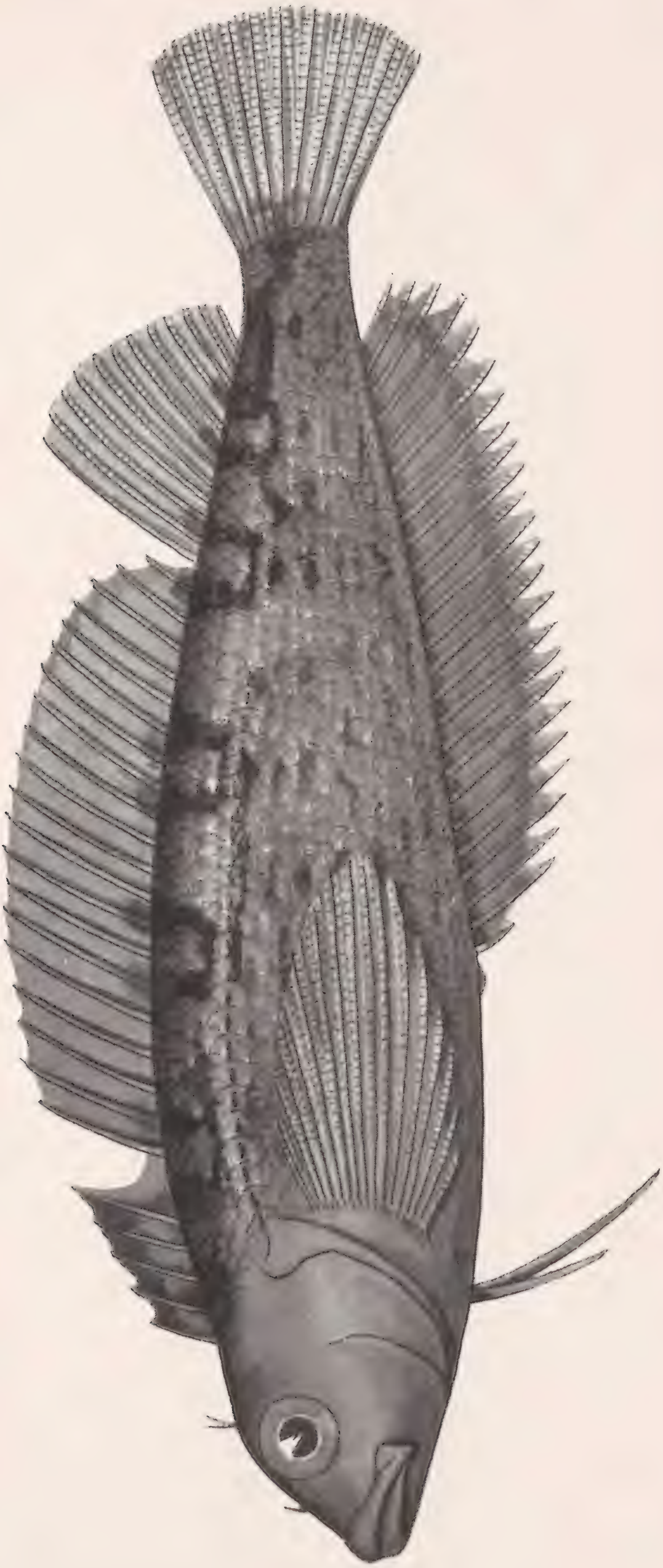
Plate V.

Ericentrus rubrus Hutton.

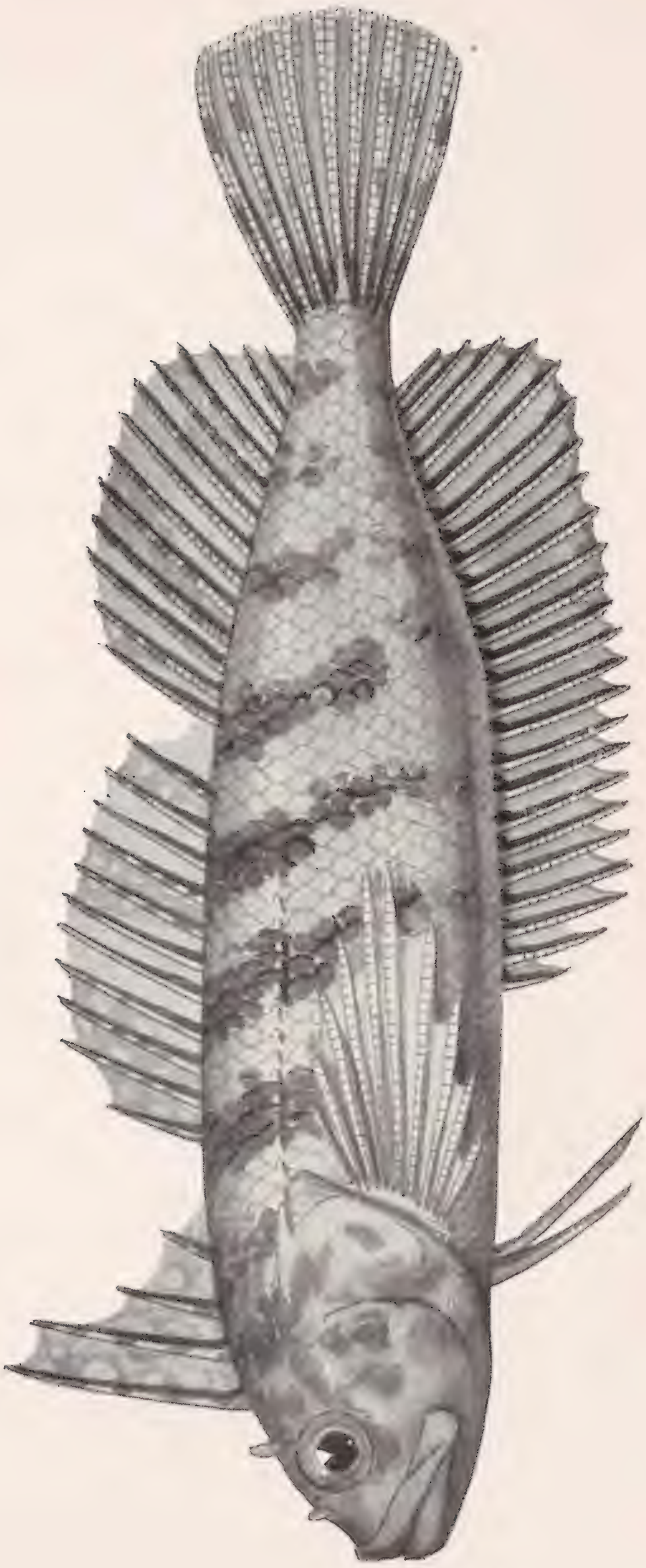
Twice natural size.

Edgar R. Waite, del.

Edgar R. Waite, del.



Edgar R. Waite, del.



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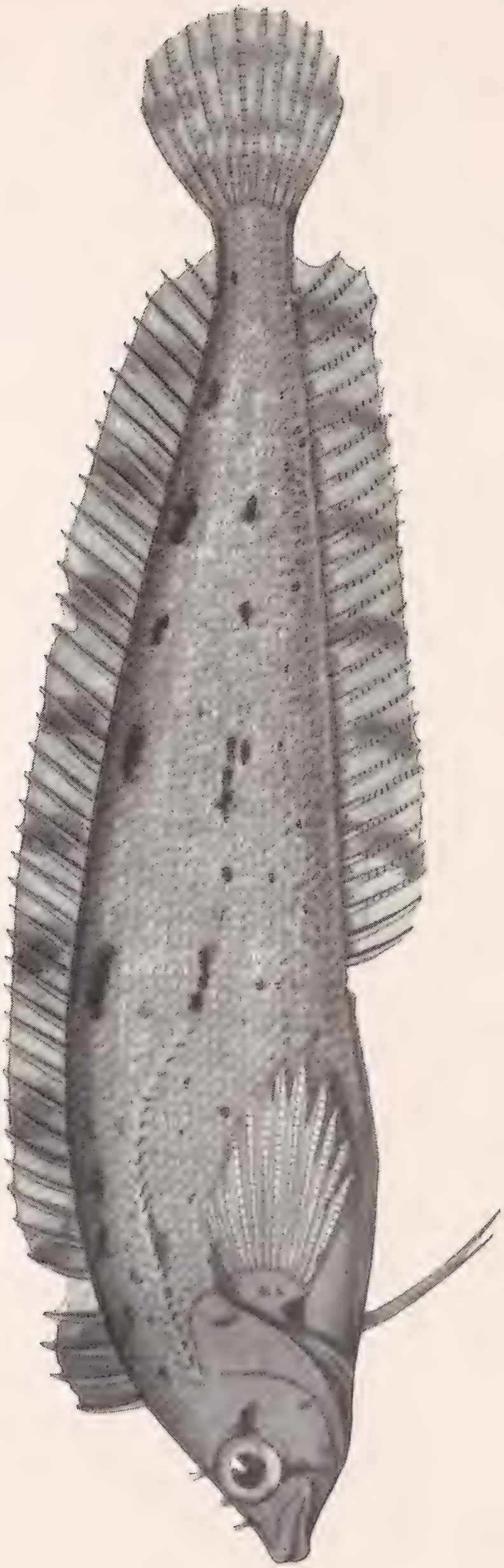

Edgar R. Waite. del.

RESULTS of an EXAMINATION

OF SOME

DRAWINGS of NEW ZEALAND FISHES

By Edgar R. Waite, F.L.S., *Curator.*

Plate VI.

Mr. A. Hamilton, Director of the Dominion Museum, Wellington, placed in my hands for report, some old drawings and photographs of fishes discovered in a portfolio in the Museum. The majority of them are named in the handwriting of Sir James Hector, and call for no special mention, but some of them were not identified, and are of more than passing interest, being unfamiliar forms, of which three are new to the known fauna of New Zealand, namely, *Gempylus serpens* Cuvier and Valenciennes, *Germo germon* Lacépède, and *Luvarus imperialis* Rafinesque.

Mr. T. F. Cheeseman, Curator of the Auckland Museum, also sent me a few photographs, and some of these are likewise referred to below.

Echinorhinus brucus Bonnaterre.

Squalus brucus Bonnaterre, Tabl. Encycl. Ichth., 1788, p. 11.

Echinorhinus spinosus Blainville, Bull. Sci. 1816, p. 121.

This species was first recorded as a member of the New Zealand fauna by Parker,[7] who identified the teeth and tail of a specimen caught off Dunedin in July, 1883.

One of the photographs sent by Mr. Cheeseman represents this species. The subject was stranded at Opotiki in the Bay of Plenty, and the following are supplied as dimensions:—

Length.—8ft. 5in., *girth* 5ft. 6in., *weight* about 3½cwt.

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(7) Parker, T.N.Z.I. xvi. 1884, p. 280.

Plagiogeneion rubiginosus Hutton.

Therapon rubiginosus Hutton, T.N.Z.I. viii. 1876, p. 209.

Plagiogeneion rubiginosus Forbes, *ib.* xxii. 1890, p. 273.

Waite, *ib.* xlv. 1913, p. 218, pl. vii.

A drawing by Miss Nellie Drew of Wanganui, represents this fish. It was sent to Sir James Hector, with a note to the effect that the fish was taken at Kapiti Island in Cook Strait, July 2nd, 1879, and that its colour was silvery pink. The collection also includes a photograph of the same species but without note of any kind.

It might appear that this species is subject to similar conditions which drive the Frost fish (*Lepidopus*) ashore, for all occurrences recorded are in the winter months, and the fish has never been obtained except when stranded. A week after my paper, above noted, was published, namely on June 18th, 1913, Mr. F. W. Armstrong, of New Brighton, brought me a perfect specimen which he had picked up on the beach, and on July 7th Mrs. R. Hartley sent me an example stranded on the beach at Okain's Bay, Banks Peninsula. On July 14th Professor Benham, of the Otago University, wrote to me that he had received a specimen picked up at Moeraki, and he mentions as a curious coincidence that he should have obtained the species, regarded as rare, about the time I had secured the fishes locally, and of which I had apprised him. Mrs. Wilfrid Hall tells me that many years ago she presented a specimen to the Museum taken on the beach at Governor's Bay, Lyttelton Harbour. This is possibly the second specimen referred to in my paper.

Both new specimens in my hands have twelve spines and eleven rays in the dorsal fin, as in the specimen figured. The life colours are really gorgeous, the body being ruby coloured above and silvery beneath, the fins bright crimson.

This fish is allied to *Emmelichthys* but differs, among other details, by being much deeper in the body, and by having the dorsal spines wholly connected by membrane. *Erythrichthys* agrees with the latter in respect to its general proportions but is characterised by having the dorsal spines more or less isolated. *Erythrichthys schlegeli* is said to be an inhabitant of deep water.

Germo germon Lacépède.

Scomber germon Lacépède, Hist. Nat. Poiss. ii. 1800, p. 598 and iii. 1802, p. 1.

Germo germon Fowler, Proc. Acad. Nat. Sci. Phil. 1904, (1905), p. 761 (which see for synonomy).

The drawing is by Mr. G. H. Wilson, Survey Office, Gisborne, and is marked "Bonita, captured by Mr. John Somervell in the Turanganui River, April 13th, 1885." The drawing, in black and white, is stated to be of natural size, and is 478 mm. (18¾ inches) in length. It is made with the care usually taken by survey draughtsmen, and certainly represents a fish of the genus *Germo*. Translating such terms as "back fin and side fin," the following notes are made on the drawing, "Dorsal spines xiv., eight finlets each in dorsal and anal, the pectoral extends to the origin of the anal, the fins fit into grooves and there are no obstructions to movement through the water. The colours are black on the back, graduated to indigo on the sides, belly silvery, shot with tints of golden green, a dark spot on each caudal lobe, scales very fine, small and silken to the touch."

The Long-finned Albacore of the Pacific is usually associated with *Germo alalunga* (*Scomber alatunga* Gmelin) of the Atlantic, but Fowler writes:—"This form has never been compared with the Atlantic fish, in view of which it would seem best to retain Lacépède's name for the Indian form." He adds: "Bennet records a fish from Polynesia, which may probably be identical." I have therefore simply adopted the suggestion without being in a position to offer any opinion on the subject.

Gasterochisma melampus Richardson.

Gasterochisma melampus Richardson, Ann. Mag. Nat. Hist. xv., 1845, p. 346, Waite, T.N.Z.I. xlv. 1913, p. 220, pl. viii.

This species is represented by a photograph sent by Mr. Cheeseman, who informs me that the fish was stranded on the north coast of Gisborne, and was nearly six feet in length.

The specimen was evidently adult and exhibits all the features mentioned in my previous note on the species. Since that was written I find that Mr. David G. Stead, of Sydney, recorded the capture of two specimens at Shoalhaven, New South Wales, in August 1906.[8] They measured respectively 372 and 405 mm. in length, and were thus intermediate in size, between

(8) Pub. Dept. of Fisheries, N.S.W. "Additions No. 1," 1907, p. 21, pl. vi.

those of Richardson and Johnston. The illustration, reproduced from a photograph, which accompanies the paper, shows that although the adult characters have not been attained at that stage, they indicate a further development than the smaller example figured by Richardson. Referring to the great development of the ventral fins in the young, Mr. Stead writes:—"The possession of these relatively enormous ventral fins would appear at first sight to be altogether out of keeping with a fish which is quite obviously pelagic in habit and a rapid swimmer; but when the highly compressed form and somewhat wedge-shaped abdomen are considered, it is seen that if the fish were moving slowly it could hardly retain its balance in the water without the aid of some such organs. Particularly must they be of use if, as is probable, this species subsists to some extent upon slow-moving pelagic organisms. Of course, in rapid swimming, the ventral fins would be laid back in their groove."

One may inquire how the adult, in which the ventral fins are so greatly reduced, succeeds in balancing itself in the water?

I should have mentioned, as Mr. Stead has done, that the identity of *Gasterochisma* and *Lepidothynnus* was first promulgated by Regan[9].

Gempylus serpens Cuvier and Valenciennes.

Gempylus serpens Cuvier and Valenciennes, Hist. Nat. Poiss. viii. 1831, p. 207.

The drawing is marked "Scabbard Fish," and consists of the head and fore part of the body, and a smaller sketch of the entire fish, which is described as scaleless, and 3ft. 5in. (1042 mm.) in length. No specific locality is mentioned, but the specimen was evidently obtained in fresh condition, for the sheet also contains drawings of a live leech-like parasite attached to the fish, and described as follows:—"This sac contains a blood-red fluid, which is in constant motion, ebbing to and fro without the sac itself undergoing any change of form."

Luvarus imperialis Rafinesque.

Plate VI.

Luvarus imperialis Rafinesque, Caratt. Alc. Gen. 1810, p. 22.

Waite, Rec. Aust. Mus. iv. 1902, p. 292, pl. xlv. xlvi.

Originally known from the Mediterranean and Atlantic, this species was first recorded from the Pacific in 1901 by Mr. C. F.

(9) Regan Ann. Mag. Nat. Hist. (Ser. 7) x. 1902, p. 120.

Holder, who published a photograph of a specimen taken at Avalon on Santa Catalina Island, off the coast of California.

In the following year I identified a specimen stranded at Bermagui on the coast of New South Wales. It would seem, however, that Mr. Holder's specimen did not present the first opportunity for recording the species from the Pacific, for one of the drawings sent by Mr. Hamilton portrays this fish. The picture is in outline, drawn with pen and ink, and bears the following words, "Cast on beach near North Cape, North Island, 1887." The drawing measures 650 mm. (25½ inches), but if to scale may be but half or even only one-third the actual size of the specimen, the retrogression of the dorsal spines indicating a mature or aged example. The drawing of Rafinesque's type specimen shows the dorsal and anal fins as originating in the same vertical, a condition of the Australian example also. In the figure published by Goode and Bean[10] two dorsal spines are shown in advance of the anal, whereas in the drawing of the New Zealand fish, the origin of the first dorsal spine is posterior to the third of the anal. Though the anal fin also suffers regression it is evidently affected to a lesser degree than is the dorsal.

The drawing is rather diagrammatic but has been carefully done, and it is reproduced herewith, artist C.H.P.

EXPLANATION OF PLATE VI.

Luvarus imperialis Rafinesque.

Greatly reduced from a drawing by "C.H.P."

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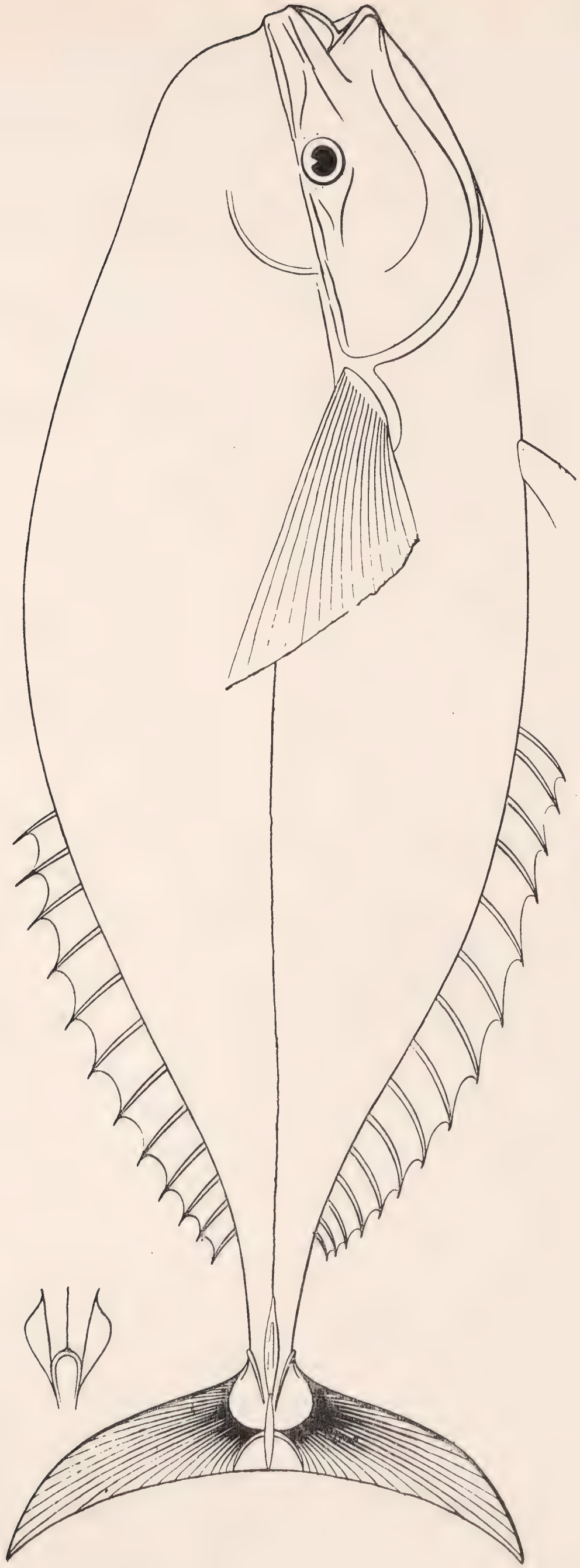
(10) Goode and Bean, Oceanic Ichth. 1895, pl. lxiv., fig. 230.



C.H.P. del.

A SUPPOSED OCCURRENCE OF THE BOTTLE-NOSED WHALE *(HYPEROODON)* IN NEW ZEALAND

By Edgar R. Waite, F.L.S., Curator.

Plates VII. and VIII.

In the "Guide Book to the Whales and Dolphins of New Zealand" I noted that *Hyperoodon* had been recently recorded from New Zealand[11], but that, at the time of writing details were not to hand.

I now learn that the specimen was found stranded by my friend, Captain John Bollons, of the Government steamer *Hinemoa*, who has placed in my hands the extremity of the mandible, which he had sawn off. He supplies the following particulars of this occurrence, and if the determination is correct another species is added to our known fauna. The bottle-nosed whale was found stranded on the beach at East Cape (the most easterly point of New Zealand), and was twenty-five feet in length. The lower jaw measured two and a half feet, and the teeth were imbedded half an inch below the gum. The specimen was in a considerably decayed condition when discovered, and the tip of the mandible was the only portion of the animal preserved.

I have previously referred to Captain Bollons's interest in, and knowledge of, marine life, and he not only identified the whale from external appearance, but took pains to secure one of its most characteristic features. The record above mentioned appeared in the newspapers on information supplied by Captain

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(11) Guide Book, Canterbury Museum, 1912, p. 15, footnote.

Bollons, who stated that the Whale had been discovered stranded, during his periodic visit to the lighthouses on the New Zealand coast.

The characteristic features of the Ziphioid or Beaked Whales, hitherto recorded from New Zealand, are so pronounced that there is small difficulty in determining to what genus any specimen should be assigned, providing, of course, that the peculiar diagnostic features of the individual are preserved.

Though the specimen now under notice consists only of a small portion of the mandible, it can be definitely said that it is referable neither to *Berardius* or *Mesoplodon,* but possesses characters, generally speaking, common to *Ziphius* and *Hyperoodon,* that is, there is only one pair of teeth in the mandible and these teeth are situated at the extremity of the jaw.

In the absence of specimens of both genera for comparison, accurate determination may be impossible, but for reasons adduced below, I am inclined to consider the bone referable to *Hyperoodon.*

The specimen preserved by Captain Bollons consists of a small piece of the anterior portion of the mandible, 115 mm. in length, the greatest width, at the sawn surface being 70 mm. Viewed from above or below the extremity is trilobed, the middle lobe being the longest, and separated from the lateral ones by two pits, from which the tusk-like teeth project. The teeth lie almost parallel to each other, are slightly curved and are inclined upwards and forwards, forming an angle of about 40 degrees with the axis of the bone. They are cemented in their sockets by a greyish-white coloured substance. The left tooth is slightly the longer, and projects 37 mm. beyond its insertion though only 23 mm. beyond the level of the median lobe. The exposed portion of the tooth is nearly circular in section, its greatest, or antero-posterior diameter being 13 mm. at its insertion. The terminal 5 mm. is composed of enamel, of which the distal half is contracted to form a nipple-like tip.

The alveolar groove extends along the outer upper edge of each ramus, and the irregularly disposed pits are supposed to have held teeth in fœtal or early life. On the underside of the mandible, and towards its tip are three pairs of orifices, the outlets of the dental canal, seen in the middle of each lateral half of the sawn surface, and shown in the photograph (Pl. VII.).

Removed from its socket, the left tooth is found to be 67 mm. in length, of which nearly half is imbedded in the bone and coated with cement. This cement closely invests the root of the

tooth, and the irregular nature of its outer surface corresponds with the irregularity of the interior of the socket. (Pl. VIII., fig. 2.)

The somewhat extensive literature on *Hyperoodon* and *Ziphius* does not help one who has but the fragment of a mandible, to any extent. The genera agree in that the lower jaw has a pair of teeth at or near the extremity of the mandible. Owen[12] figured the teeth and extremity of the lower jaw of an immature *Hyperoodon*, and thus described the teeth:—"They are conical, slightly curved, with an unusually sharp and slender apex, tipped by enamel. Though loose in their sockets, they project so little from them, and have such wide bases that they are retained in *situ*, and do not fall out in the dried jaw; two smaller cavities in front, and the remains of a larger socket in the alveolar groove, behind the retained teeth, attest the former presence of other teeth."

Owen's drawing exhibits a great similarity to our specimen. in which, however, the teeth are larger, and are placed terminally, those pictured by Owen being situated some distance behind the apex, though said to be at the extremity. The difference in the position of the teeth may be due to the instability of degenerate characters, or may be merely a question of age. The small cavities in front which Owen considered to be the sockets of previously existing teeth, are not present in our specimen unless they can be identified with what I have supposed to be an anterior branch of the canal.

The teeth of *Hyperoodon* appear to be considerably larger than those of *Ziphius*, being, according to van Beneden[13] a decimeter in length, the root included, while those of *Ziphius cavirostris*, according to the same author, are but 47 mm. long, or less than half those of *Hyperoodon*.

The Bottle-nosed Whale is a common northern species, and has been frequently cast on to British coasts. Though usually known as *Hyperoodon rostratum* Muller, True[14] dates the first diagnosis to Forster (1770), the name being therefore *H. ampullatus*. It is, however, more probable that our specimen should be referred to *H. planifrons* Flower[15] described from a water-worn cranium found at Lewis Bay, Dampiere's Archipelago, N.W. Australia. *H. ampullatus* has not been identified from southern waters, but True supplies the following localities

(12) Owen, Odontography, 1840-45, p. 347, pl. lxxxviii., fig. 1.
(13) Van Beneden and Gervais, Ostéographie des Cétacés 1880, p. 373.
(14) True, U.S. Nat. Mus. Bull., 73, 1910, p. 76.
(15) Flower, P.Z.S., 1882, p. 392.

for *H. planifrons*, some of which are, however, represented by fossil specimens:—Indian and Pacific Oceans; Lewis Island, Australia; Province of Buenos Ayres, Argentina, and territories of Chubut and Santa Cruz, Patagonia.

EXPLANATION OF PLATES.

Plate VII.

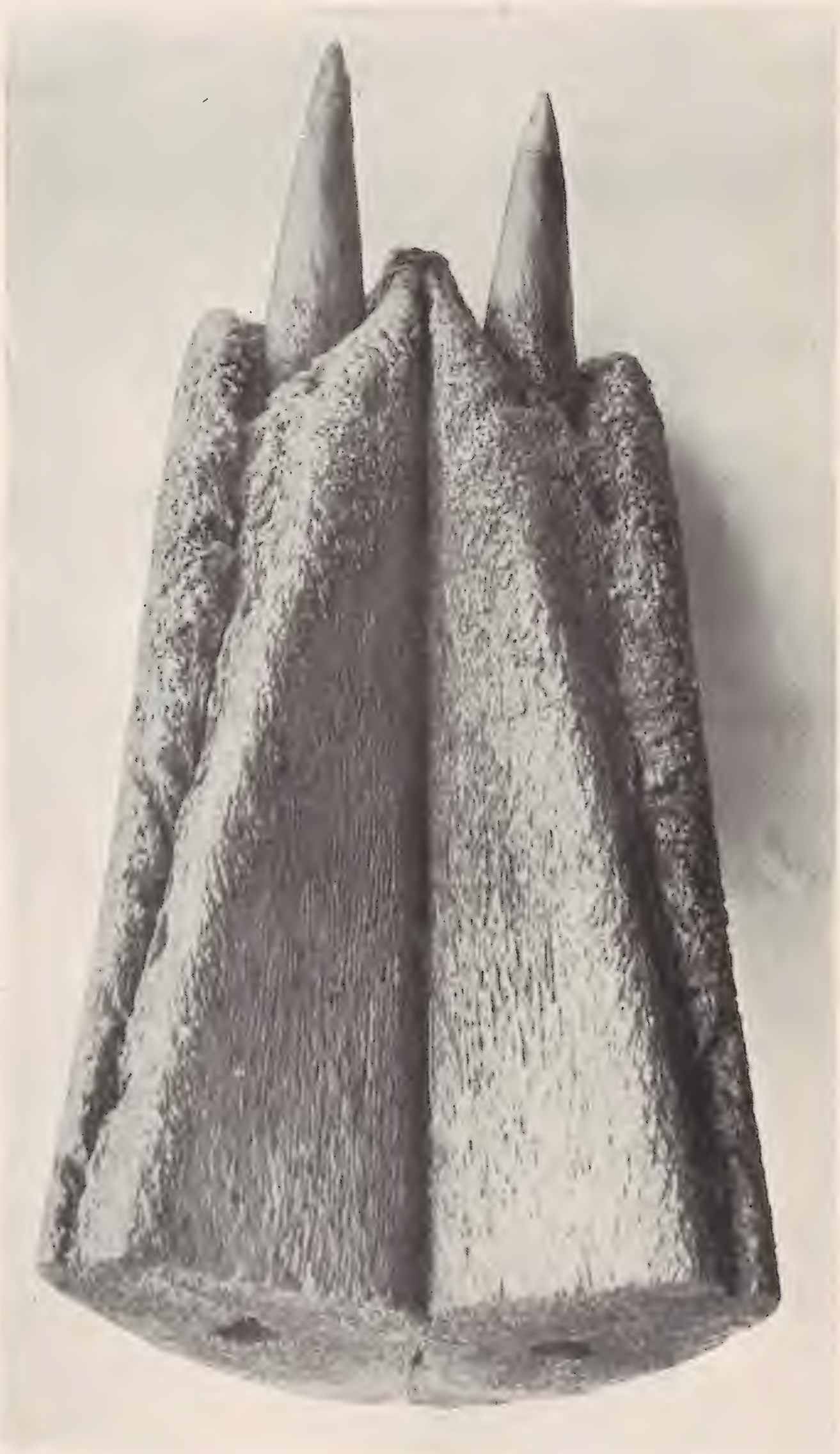
? *Hyperoodon planifrons* Flower.

Extremity of mandible, seen from above, natural size.

Plate VIII.

? *Hyperoodon planifrons* Flower.

Fig. 1.—Extremity of mandible, in profile, natural size.
Fig. 2.—Tooth removed from socket, natural size.



Leslie Hinge, photo.

Leslie Hinge, photo.

LIST OF TERTIARY MOLLUSCA

IN THE

CANTERBURY MUSEUM

By R. Speight, M.A., M.Sc., F.G.S. Assistant Curator.

In view of the efforts now being made by the Geological Survey and by private individuals to place the evidence for the subdivision of the Tertiary geological series in this country on a better footing, it has been considered advisable to publish a list of the specimens in this Museum, with the localities from which they have been obtained. Such a list will no doubt assist workers elsewhere who may wish to know what the Museum really possesses. The collection is, besides, a most important one, as it contains the fossils originally gathered by von Haast in the classic localities situated within the province of Canterbury; and also much of the material dealt with by Hutton, both before and during the time he filled the position of Curator of this Museum. This material has been derived from such well-known districts as Waipara and the Weka Pass; the Greta and Waikari Valleys; the Trelissick Basin, the home of J. D. Enys, a keen collector, whose labours have enriched the institution in numerous ways; the Curiosity Shop; Kakahu; and especially the rich horizons of Pareora, Waihao, and Mount Harris. These areas probably include some of the most noteworthy fossiliferous Tertiary localities in New Zealand. Numerous specimens have also been added to the collection from the rich Pliocene beds of Wanganui and Hawke's Bay.

In compiling this list, the author has received very substantial assistance from Mr. Henry Suter, who has lately overhauled the collection of recent Mollusca displayed in the Museum, and the classification adopted in his "Manual"[16] has been followed throughout; for his generous help on many occasions our thanks are specially due.

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(16) Suter, Manual of N.Z. Mollusca, 1913.

It has not been thought advisable at the present time to do more than give a localised list, since a much greater mass of material must be obtained from numerous localities, and collected with due regard to zonal distribution, before any satisfactory attempt at generalisation can be made, without incurring the danger of falling into serious error.

It is necessary to note that it has been considered advisable in one or two cases to select types where none were previously indicated. There can be no doubt that the material on which Hutton founded his new species described in Trans. of the N.Z. Institute, vol. IX., pp. 593-8, is still in the Museum and can be easily identified, and the types have been selected from this. Owing to the very numerous changes in nomenclature it has not been considered necessary to include the author's name in brackets when his species has been assigned to a different genus.

The number of specimens of each individual species in the collection from a particular locality is indicated by a figure in brackets following the name of the locality. One or two of these names are now difficult to assign to their proper district since place-names well known once have at times disappeared from maps and from the remembrance of settlers. Where possible a more precise indication of the locality is given. This applies to such names as Double Corner, an old abandoned station near the Lower Waipara Gorge, and also such misleading names as White Rock, which is the name of a well-known limestone quarry in North Canterbury and also of an important locality in South Canterbury, where numerous typical Pareora fossils have been obtained.

The following is a list of works of special importance in considering the synonomy of the species of New Zealand Tertiary fossil Mollusca.

"An Account of New Zealand, etc.," by Rev. William Yate. London, 1835.

An appendix to this work contains a list of shells described by Gray.

"Voyage de *l'Astrolabe,* vol. ii., Zoologie—Mollusca," by Quoy and Gaimard. Paris, 1832-5.

"Voyage de la *Coquille*—Zoologie," by Lesson and Garnot. Paris, 1826.

"New Zealand," by Dieffenbach,—Description of the Fauna by Gray. London, 1843.

"Geological Observations in South America," by Darwin.—Descriptions of Mollusca by Sowerby. London, 1846.

"Reise der Novara—Geologie, vol. ii., Pal.," by Zittel. Vienna, 1864.

"Catalogue of the Marine Mollusca of New Zealand," by Hutton. Wellington, 1873.

"Catalogue of the Tertiary Mollusca of New Zealand, by Hutton. Wellington, 1873.

"Pliocene Mollusca of New Zealand—Macleay Memorial Volume," by Hutton. Sydney, 1893.

"Mollusca of the Pareora and Oamaru Systems," by Hutton. Proc. Linn. Soc., N.S. Wales, i. (2nd Series). Sydney, 1887.

The following volumes of the Transactions of the N.Z. Institute contain descriptions of new species of Tertiary Mollusca, namely:—vii., ix., xv., xvii., xviii., xxxiv., xxxvii., by F. W. Hutton; xii., xiv., by T. W. Kirk; xxxii., xxxvii., by R. Murdoch; xl, xliii., xlv., by Henry Suter; and xl., by J. Allan Thomson.

PTEROPODA.

Fam. CAVOLINIIDAE.

Vaginella aucklandica Clarke (?); T.N.Z.I., xxxvii., 1905, p. 419, pl. xxxii, fig. 5.
Weka Pass.

GASTEROPODA.

Fam. TROCHIDAE.

Trochus nodosus Hutton; T.N.Z.I., xvii., 1885, p. 330.
Broken River. (Idio-type.)

Trochus tiaratus Quoy and Gaimard; Voy. Astrol., iii., 1834, p. 256, pl. lxiv., figs. 6-11.
Waipara (3); Lower Gorge of Waipara.

Trochus (*Coelotrochus*) *conicus* Hutton; T.N.Z.I., xv., 1883, p. 411.
Wanganui. (Type.)

Trochus sp.
Whitewater Creek, Trelissick Basin.

Ethalia zelandica Hombron and Jacquinot, Voy. Pôle Sud, v., 1854, p. 53, pl. xiv., figs. 5, 6.
Wanganui (2).

Callistoma spectabile Adams; P.Z.S., 1854 (1855), p. 37, pl. xxvii., fig. 7.
Broken River (4).

Callistoma hodgei Hutton; T.N.Z.I., vii., 1875, p. 458, pl. xxi.
Wanganui. This has been marked "type" by Hutton, but Mr. Suter notes that it cannot be the type, which is a somewhat larger example in the Otago Museum. See T.N.Z.I., vii., 1875, p. 458.

Callistoma ponderosum Hutton; T.N.Z.I., xvii., 1885, p. 322.
Wanganui. (Type.)

Fam. Turbinidae.

Turbo marshalli Thomson; T.N.Z.I., xl., 1908, p. 103, pl. xiv., fig. 6.
Tuffs below limestone, Kakanui.

Turbo superbus Zittel; Reise Novara, Geol. ii. Pal., 1864, p. 39, pl. xiv., fig. 2.
Porter River (4).

Astræa heliotropium Martyn; Univ. Conch., i., 1784, fig. 30 (not of 1769.)
Wanganui.

Fam. Rissoidae.

Rissoa olivacea Hutton; T.N.Z.I., xiv., 1882, p. 147, pl. i., fig. K, 1-4.
Petane (6).

Rissoa gradata Hutton; T.N.Z.I., xvii., 1885, p. 321, pl. xviii., fig. 21.
Wanganui (Lecto-type).

Rissoina rugulosa Hutton; Cat. Mar. Moll., 1873, p. 28.
Petane.

Rissoa impressa Hutton; T.N.Z.I., xvii., 1885, p. 321.
Petane (Lecto-type).

Rissoa (*Alvania*) *rugosa* Hutton; T.N.Z.I., xvii., 1885, p. 321.
Petane (Lecto-type).

Rissoina (*Zebina*) *emarginata* Hutton; T.N.Z.I., xvii., 1885, p. 320, pl. xviii., fig. 20.
Wanganui (Type).

Rissoa (*Onobia*) *semisulcata* Hutton; T.N.Z.I., xvii., 1885, p. 321.
Wanganui (Lecto-type).

Fam. Vermetidae.

Serpulorbis zelandicus Quoy and Gaimard; Voy. Astrol., iii., 1834, p. 293, pl. lxvii., figs. 16, 17.
Wanganui.

Serpulorbis sipho Lamarck; Anim. s. Vert. v., 1818, p. 626.
(= *Cladopoda monilifera* Hutton; Cat. Tert. Moll. p. 13.)
Wanganui.

Fam. Turritellidae.

Turritella pagoda Reeve; Conch. Icon., v., fig. 60.
Te Ngawai; White Rock River (10).

Turritella cavershamensis Harris; Cat. Tert. Moll. Brit. Mus., part I., 1897, p. 242.
White Rock River (2); Pareora River (2). Another fine specimen has no locality indicated.

Turritella carlottæ Watson; Journ. Linn. Soc., xv., 1881, p. 222, (= *T. vittata* Hutton).
Wanganui.

Turritella rosea Quoy and Gaimard; Voy. Astrol., iii., 1834, p. 136, pl. lv., figs. 24-26.
var. *A.* of Hutton, White Rock River (4); Blue Cliffs, Otaio, (2); Mount Harris (2); Point Hill, Waitaki (3); Motunau (3); Greta (3); Westland (3); Wanganui (2).

Turritella bicincta Hutton; Cat. Tert. Moll. 1873, p. 13.
Petane (5).

Turritella symmetrica Hutton; Cat. Mar. Moll., 1873, p. 30.
Greta (3); Porter River (7); White Rock River (6); Lower Gorge of the Waipara River (3); Wanganui (2).

Eglisia striolata Hutton; T.N.Z.I., xvii., 1885, p. 329.
White Rock River (Holotype and fourteen paratypes).

Eglisia planostoma Hutton; T.N.Z.I., xvii., 1885, p. 320, pl. xviii., fig. 19.
Petane (Type).

Fam. Struthiolariidae.

Struthiolaria cincta Hutton; Cat. Tert. Moll., 1873, p. 11.
Waikari; Greta (2); Lower Gorge of Waipara.

Struthiolaria frazeri Hutton; T.N.Z.I., xvii., 1885, p. 329.
Motunau.

Struthiolaria vermis Martyn; Univ. Conch., ii., 1784, fig. 53.
var. *A.* Matapiro, Hawke's Bay; Woodville; var. *B.* Wanganui (2).

Struthiolaria (*Pelicaria*) *obesa* Hutton; T.N.Z.I., xvii., 1885, p. 329.
Shepherd's Hut, Waipara (Type); Porter River.

Struthiolaria parva Hutton; M.S., Suter.
(Chiro-type). Locality unspecified.

Struthiolaria cingulata Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 35, pl. xv., fig. 2.
Porter River; Motunau; Mount Harris; Lower Gorge of Waipara.

Struthiolaria tuberculata Hutton; Cat. Tert. Moll., 1873. p. 11.
Pareora; Waikari; Lower Gorge of Waipara.

Struthiolaria spinosa Hector; T.N.Z.I., xviii., 1886, p. 335.
Waikari; Broken River (2); Kakahu.

Struthiolaria calcar Hutton; T.N.Z.I. xviii., 1886, p. 335.
Te Ngawai Cliff.

Struthiolaria papulosa Martyn; Univ. Conch., ii., 1784, fig. 54.
Wanganui; Pareora.

Struthiolaria caniculata Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 34, pl. xv., fig. 1.
Lower Gorge of Waipara.

Fam. Calyptraeidae.

Crepidula gregaria Sowerby; in Darwin's "Geol. Obs. S. Amer.," 1846, p. 254, pl. iii., fig. 34.
Pareora (2); Motunau (2); Waikari (4).

Crepidula crepidula Linné; Mus. Lud. Ulricae, 1764, p. 639.
Porter River (4); White Rock River (2); Wanganui (5).

Crepidula aculeata Gmelin; Syst. Nat., ed. 13, 1789, p. 3693.
Broken River; Wanganui (2).

Calyptræa maculata Quoy and Gaimard; Voy. Astrol., iii., 1835, p. 422, pl. lxxii., figs. 6-9.
Wanganui (3); Porter River (2).

Calyptræa maculata inflata Hutton; T.N.Z.I., xv., 1883, p. 411.
Wanganui (Type).

Calyptræa alta Hutton; T.N.Z.I., xvii., 1885, p. 329.
Petane (Lecto-type); White Rock River.

Calyptræa scutum Lesson; Voy. Coquille, Zool. xi., 1830, p. 395.
Waikari; Puketapu, Napier; Wanganui; Point Hill, Waitaki (4); Lower Gorge of Waipara.

Fam. NATICIDAE.

Polinices (*Lunatia*) *suturalis* Hutton; T.N.Z.I., ix., 1877, p. 597, pl. xvi., fig. 11.
Awamoa; Waitaki; Mount Horrible, Pareora; Waihao.

Polinices ovatus Hutton; Cat. Tert. Moll., 1873, p. 9.
Broken River; Pareora; Waikari; White Rock River; Lower Gorge of Waipara.

Polinices gibbosus Hutton; T.N.Z.I., xviii., 1886, p. 334.
Broken River (Type); Pareora; White Rock River; Waihao.

Polinices huttoni v. Ihering; Anal. Mus. Nat. Buenos Aires, xiv., 1907, p. 154, pl. v., fig. 16 (= *N. solida* Sowerby; Darwin's Geol. Obs. on S. America, p. 255).
Fox's Gully; Arahura River; Lower Gorge of Waipara.

Polinices (*Lunatia*) *cinctus* Hutton; T.N.Z.I., xvii., 1885, p. 318, pl. xviii., fig. 12.
Wanganui (Type).

Polinices laevis Hutton; T.N.Z.I., xvii., 1885, p. 317, pl. xviii., fig. 10.
Petane (Type); Wanganui.

Natica australis Hutton; Jour. de Conch., xxvi., 1878, p. 23.
Wanganui; Porter River; White Rock River.

Natica zelandica Quoy and Gaimard; Voy. Astrol., ii., 1832, p. 237, pl. lxvi., fig. 11-12.
White Rock River; Wanganui.

Ampullina miocœnica Suter; N.Z. Geol. Survey., Paleont. Bulletin No. 2, part 1., 1913, p. 21, pl. ii., fig. 2.
(= *Sigaretus sub-globosus* Hutton *non* Sowerby).
White Rock River (2); Te Ngawai.

Ampullina undulata Hutton; T.N.Z.I., xvii., 1885, p. 318, pl. xviii., fig. 11.
Wanganui (Type).

Fam. CYPRAEIDAE.

Cypraea ficoides Hutton; Cat. Tert. Moll., 1873, p. 8.
Oamaru (2).

Cypræa ovulatella Tate; T.R.S. S. Austr., xiii., 1890, p. 208, pl. vi., fig. 7 (= *Marginella ventricosa* Hutton).
Porter River.

Trivia zealandica T. W. Kirk; T.N.Z.I., xiv., 1882, p. 409.
Petane (6).

Fam. Septidae.

Cymatium spengleri Chemnitz; Conch. Cal., xi., 1795, p. 117, pl. cxi., figs. 1839-40.
Wanganui; Greta.

Cymatium minimum Hutton; Cat. Tert. Moll., 1873, p. 5.
White Rock River (2).

Fam. Cassididae.

Phalium orchatinum pyrum Lamark; Anim. sans vert., vii., 1822, p. 226.
Wanganui.

Galeodea sulcata Hutton; Cat. Tert. Moll., 1873, p. 8.
Pareora (3); Lower Gorge of Waipara; Fox's Gully, Arahura.

Galeodea senex Hutton; Cat. Tert. Moll., 1873, p. 11.
Oamaru; Curiosity Shop, Rakaia; Pareora; Lower Gorge of Waipara.

Fam. Epitoniidae.

Epitonium (*Cirsotrema*) *zelebori* Dunker; Verh. Zool. Bot. Gesellsch, xvi., 1866, p. 912.
White Rock River; Wanganui.

Epitonium (*Cirsotrema*) *marginatum* Hutton; T.N.Z.I., xvii., 1885, p. 330.
Curiosity Shop (Type).

Epitonium (*Cirsotrema*) *nympha* Hutton; T.N.Z.I., xvii., 1885, p. 321.
Petane (Type).

Epitonium (*Cirsotrema*) *rotundum* Hutton; Cat. Tert. Moll., 1873, p. 10.

Epitonium (*Cirsotrema*) *rugulosum lyratum* Zittel; Voy. Novara, Geol. ii., Pal., 1864, p. 41, pl. ix., fig. 8.
Lower Gorge of Waipara (2); Curiosity Shop.

Epitonium (*Cirsotrema*) *browni* Zittel; Voy. Novara, Geol. ii., Pal., 1864, p. 42, pl. ix., fig. 9.
Opihi; White Rock River (2).

Lissospira corulum Hutton; T.N.Z.I., xvii., 1885, p. 322, pl. xviii., fig. 22.
Wanganui (Type).

Fam. Pyramidellidae.

Eulimella media Hutton; T.N.Z.I., xvii., 1885, p. 318, pl. xviii., fig. 13.
Wanganui (Type).

Eulimella deplexa Hutton; T.N.Z.I., xvii., 1885, p. 318.
Wanganui (Type).

Turbonilla zealandica Hutton; Cat. Mar. Moll., 1873, p. 22.
Wanganui.

Odostomia georgiana Hutton; T.N.Z.I., xvii., 1885, p. 319, pl. xviii., fig. 16.
Wanganui (Type).

Odostomia rugata Hutton; *O. plicata* Hutton; T.N.Z.I., xvii., 1885, p. 319, pl. xviii., fig. 17.
Wanganui (Type); White Rock River.

Odostomia huttoni Suter; T.N.Z.I., xl., 1908, p. 368 (= *O. fasciata* Hutton *non* Dunker).
Wanganui (Type).

Odostomia sherriffii Hutton: T.N.Z.I., xv., 1883, p. 411.

Odostomia sp.?
White Rock River.

Aclis costellata Hutton; T.N.Z.I., xvii., 1885, p. 319, pl. xviii., fig. 14.
Wanganui (Type).

Fam. Eulimidae.

Eulima treadwelli Hutton; T.N.Z.I., xvii., 1885, p. 318 (= *E. micans* Hutton, not of Tenison Woods).
Wanganui (Type).

Eulima (*Arcuella*) *obliqua* Hutton; T.N.Z.I., xvii., 1885, p. 318.
Petane (Type).

Fam. Fasciolaridae.

Fusinus spiralis A. Adams; Proc. Zool. Soc., 1855 (1856), p. 221.
Wanganui (2); Waikari.

Fusinus spiralis dentatus Hutton; T.N.Z.I., ix., 1877, p. 594.
Mount Harris (Holotype).

Fusinus tegens Hutton; T.N.Z.I., ix., 1877, p. 594.
White Rock River (Holotype).

Latirus brevirostris Hutton; T.N.Z.I., ix., 1877, p. 596, pl. xvi., fig. 10.
White Rock River (Holotype).

Latirus huttoni Suter; T.N.Z.I., xl., 1908, p. 369, pl. xxx., fig. 3. (= *Taron dubius* Hutton).
Wanganui.

Fam. Mitridae.

Mitra inconspicua Hutton; T.N.Z.I., xvii., 1885, p. 326.
Mount Harris (Holotype and one paratype); Waihao.

Mitra (*Cancilla*) *hectori* Hutton; T.N.Z.I., xxxvii., 1905, p. 473, pl. xliv., fig. 2.
Waihao, near Coal-mine (Holotype).

Mitra enysi Hutton; Cat. Tert. Moll., 1873, p. 7.
Pareora.

Vexillum apicale Hutton; Cat. Tert. Moll., 1873, p. 7.
Awamoa; Pareora.

Vexillum marginatum Hutton; T.N.Z.I., xvii., 1885, p. 315. pl. xviii., fig. 4.
Wanganui (Holotype).

Vexillum linctum Hutton; T.N.Z.I., xvii., 1885, p. 326.
Petane (Holotype).

Vexillum rubiginosum Hutton; Cat. Mar. Moll., 1873, p. 20.
Petane.

Vexillum planatum Hutton; T.N.Z.I., xvii., 1885, p. 315, pl. xviii., fig. 3.
Petane.

Fam. Chrysodomidae.

Siphonalia caudata Quoy and Gaimard; Voy. Astrol., ii., 1833, p. 503, pl. liv., figs. 20, 21.
Wanganui; Greta.

Siphonalia dilatata Quoy and Gaimard, Voy. Astrol., ii., 1833, p. 498, pl. xxxiv., figs. 15-16.
Mount Harris; White Rock; Pareora; Kakahu; Waikari.

Siphonalia nodosa Martyn; Univ. Conch., i., 1784. *Buccinum*, fig. 5.
Wanganui.
var. *B.* Hutton; Wanganui; Goldsborough, Westland (2); Waihao.
var. *conoidea* Hutton; Matapiro; Greta; Arahura.

Siphonalia subnodosa Hutton; T.N.Z.I., ix., 1877, p. 596, pl. xvi., fig. 7.
White Rock River; Waikari (2).

Siphonalia costata Hutton; T.N.Z.I., ix., 1877, p. 594, pl. xvi., fig. 2.
Mount Harris; Mount Horrible.

Siphonalia orbita Hutton; T.N.Z.I., xvii., 1885, p. 326.
Greta (Type); Lower Gorge of Waipara River.

Siphonalia mandarina Duclos; Mag. de Zool., 1831, p. 8.
Wanganui (3).

Siphonalia regularis Sowerby (?); Darwin's "Geol. Obs. in S. America," p. 258, pl. iv., fig. 55.
Awamoa; Pareora.

Siphonalia sp.?
White Rock River.

Euthria drewi Hutton; T.N.Z.I., xv., 1883, p. 410.
Wanganui (Type).

Euthria linea Martyn; Univ. Conch., ii., 1784. *Buccinum*, fig. 48.
Wanganui (2).

Euthria linea traversi Hutton; Cat. Mar. Moll., 1873, p. 9.
Greta; Wanganui (2).

Euthria striata Hutton; T.N.Z.I., vii., 1875, p. 458, pl. xxi.
Wanganui (2).

Euthria media Hutton; T.N.Z.I., xvii., 1885, p. 326.
Waikari (Holotype and two paratypes).

Euthria martensiana Hutton; Journ. de Conch., xxvi., 1878, p. 16.
Wanganui.

Euthria sp.?
White Rock River.

Fam. Buccinidae.

Cominella maculata Martyn; Univ. Conch. *Buccinum*, ii., 1784, fig. 49.
White Rock River; Shepherd's Hut, Waipara; Porter River, Trelissick Basin; Matapiro, Hawke's Bay.

Cominella nassoides Reeve; Conch. Icon., iii., *Buccinum*, fig. 12.
Petane.

Cominella huttoni Kobelt; Jahrb. d. Deutsch. Mal. Ges., 1878, p. 233 (= *C. hamiltoni* Hutton; T.N.Z.I., xvii., 1885, p. 316, pl. xviii., fig. 7.
Petane (6); Porter River.

Cominella virgata H. and A. Adams; Gen. of Moll., i., 1853, p. 110, iii., pl. xi., fig. 6.
Wanganui.

Cominella monilifera Hutton; T.N.Z.I., xvii., 1885, p. 327.
Waipara (Type).

Cominella acuminata Hutton; Pliocene Moll. of N.Z., p. 43, pl. vi., fig. 14; *C. elongata* Hutton; T.N.Z.I., xvii., 1885, p. 315, pl. xviii., fig. 5; not of Dunker.
Wanganui (Lecto-type and two paratypes).

Cominella lurida Philippi; Zeitschr., f. Malak, 1848, p. 137.
Wanganui.

Cominella costata Quoy and Gaimard; Voy. Astrol., ii., 1833, p. 417, pl. xxx., figs. 17-18.
Cheviot.

Cominella inflata Hutton; Cat. Tert. Moll. 1873, p. 6.
Mount Horrible; Porter River.

Phos cingulatus Hutton; T.N.Z.I., xvii., 1885, p. 327.
Greta (Holotype and two paratypes).

Phos incisus Hutton; T.N.Z.I., xvii., 1885, p. 328.
Te Aute (Type).

Alectrion socialis Hutton; T.N.Z.I., xviii., 1886, p. 333; *Nassa compta* Hutton, *l.c.* ix., 1877, p. 596, pl. xvi., fig. 9.
White Rock River (Holotype); Awamoa.

Fam. Muricidae.

Typhis maccoyi J. Ten. Woods; Pap. Roy. Soc. Tasm., 1875, p. 22, pl. i., fig. 5 (= *T. hebetatus* Hutton).
Mount Harris (4).

Murex zelandicus Quoy and Gaimard; Voy. Astrol., Zool. ii., 1833, p. 529, pl. xxxvi., figs. 5-7.
Mount Harris; Wanganui (3).

Murex octogonus Quoy and Gaimard; Voy. Astrol., Zool. ii., 1833, p. 531, pl. xxxvi., figs. 8-9.
Wanganui.

Murex octogonus espinosus Hutton; T.N.Z.I., xviii., 1886, p. 333.
Wanganui (Type and one paratype).

Trophon ambiguus Philippi; Abbild. *Fusus*, 1844, pl. i., fig. 2.
Wanganui (4).

Trophon cheesemani Hutton; N.Z. Journ. Sc., i., 1882, p. 69.
Wanganui.

Trophon bonneti Cossmann; Ess. Pal. Comp., v., 1903, p. 200, pl. iii., fig. 7.
Wanganui.

Trophon (*Kalydon*) *huttoni* Murdoch; T.N.Z.I., xxxii., 1900, p. 217, pl. xx., fig. 1.
Wanganui (Type).

Trophon (*Xanthochorus*) *expansus* Hutton; T.N.Z.I., xv., 1883, p. 410.
Wanganui (Type); Wanganui; Petane.

Trophon plebeius Hutton; Cat. Mar. Moll., 1873, p. 9.
Wanganui (5); Lower Gorge of Waipara.

Trophon corticatus Hutton; Cat. Mar. Moll., 1873, p. 9.
Petane (4).

Trophon gouldi Cossmann; Ess. Pal. Comp. v., 1903, p. 54,
Petane (7).

Fam. Thaisidae.

Thais striata Martyn; Univ. Conch. pl. vii. *Buccinum* i., 1784.
Greta (2); Broken River.

Fam. Cancellaridae.

Admete lacunosa Hutton; T.N.Z.I., xvii., 1885, p. 320.
Petane (Type).

Fam. Pyrenidae.

Mitrella choava Reeve; Conch. Icon., xi., 1859, pl. xxxvii., fig. 239.
Wanganui.

Alcira varians Hutton, T.N.Z.I., xvii., 1885, p. 314, pl. xviii., fig. 2.
Wanganui (Lecto-type and four paratypes).

Alcira angustata Hutton; T.N.Z.I., xviii., 1886, p. 333.
Petane (Type).

Anachis cancellaria Hutton; T.N.Z.I., xvii., 1885, p. 314.
Petane (Lecto-type and one paratype).

Anachis pisaniopsis Hutton; T.N.Z.I., xvii., 1885, p. 314.
Petane (Lecto-type and six paratypes).

Fam. Volutidae.

Fulguraria arabica Martyn; Univ. Conch., ii., 1784, fig. 52.
Waikari; Broken River (3); Porter River; Mount Harris.

Fulguraria arabica elongata Swainson; Exot. Conch., 1821, pls. xx-xxi.
Mount Harris; Pareora; Broken River; Waikari.

Fulguraria gracilis Swainson; Exot. Conch., xx., 1821, pl. xlii.
Wanganui; Greta; Porter River.

Fulguraria attenuata Hutton; Quart. Journ. Geol. Soc., xli., 1885, p. 555.
Waipara; Pareora.

Fulguraria (*Alcithoe*) *aculeata* Hutton; T.N.Z.I., xvii., 1885, p. 325.
White Rock River (Lecto-type and one paratype); Waihao Forks.

Lapparia corrugata Hutton; Cat. Tert. Moll., 1873, p. 7.
Greta; Orari; Mount Harris (4); Waihao; Goldsborough, Westland.

Volutospina (*Athleta*) *huttoni* Suter; var. *pseudorarispina* (McCoy) Suter; N.Z. Geol. Survey, Palæont. Bulletin, No. 2, part 2.
Kakahu; Porter River; Broken River.

Fam. Olividae.

Olivella neozelanica Hutton; T.N.Z.I., xvii., 1885, p. 314, pl. xviii., fig. 1.
Patea (Type); Greta; Shepherd's Hut, Waipara.

Ancilla australis Sowerby; Spec. Conch., i., 1830, p. 7, figs. 44-46.
Waihao (2); Wanganui (2); Porter River, Trelissick Basin (3); Motunau; Lower Gorge of Waipara.

Ancilla depressa Sowerby; Thes. Conch., iii., 1859, p. 63, pl. ccxi., fig. 3.
Wanganui (Type of *A. lata*, Hutton); Te Ngawai (2); Waikopiro, Wellington (2); Pareora; Lower Gorge of Waipara; Awamoa; Shakespeare Cliff, Wanganui.

Ancilla hebera Hutton; Cat. Tert. Moll., 1873, p. 6.
White Rock (2); Pareora (3); Waikari; Lower Gorge of Waipara.

Ancilla, sp.?
Awamoa.

Fam. Marginellidae.

Marginella dubia Hutton; Cat. Tert. Moll., 1873, p. 8.
Broken River.

Marginella hectori T. W. Kirk; T.N.Z.I., xiv., 1882, p. 409.
Petane (3).

Marginella pygmada Sowerby; Thes. Conch., i., 1846, p. 386, pl. lxxv., figs. 78-79.
Petane (6).

Marginella albescens Hutton; Cat. Mar. Moll., 1873, p. 19.
Awamoa (10).

Fam. Turritidae.

Turris altus Harris; Cat. Tert. Moll. Brit. Mus., part i., 1897, p. 45.
Awamoa (2); Mount Harris; Petane.

Turris nexilis Hutton; T.N.Z.I., xvii., 1885, p. 317, pl. xviii., fig. 9; sub. sp. *bicarinatus* Suter (M.S.).
Wanganui (Holotype and four paratypes).

Drillia buchanani Hutton; Cat. Tert. Moll. 1873, p. 4.
Petane (3); White Rock River (3); Wanganui.

Drillia wanganuiensis Hutton; Cat. Tert. Moll., 1873, p. 4.
Petane (4); Wanganui (5); var. Wanganui (10).

Drillia (*Crassipira*) *aequistriata* Hutton; T.N.Z.I., xviii., 1886. p. 334.
Petane (Holotype and two paratypes); Wanganui (?) (4).

Drillia laevis Hutton; Cat. Mar. Moll., 1873, p. 12.
Wanganui.

Drillia (*Crassispira*) *plicatella* Hutton; T.N.Z.I., xviii., 1886. p. 333.
Wanganui (Holotype).

Surcula hamiltoni Hutton; T.N.Z.I., xxxvii., 1905, p. 472, pl. xliv., fig. 1.
Waihao Forks (Holotype).

Surcula fusiformis Hutton; T.N.Z.I., ix., 1877, p. 595, pl. xvi., fig. 3.
Otaio; Awamoa; Waihao (4).

Surcula huttoni Suter; N.Z. Geol. Survey; Palæont. Bulletin No. 2, part 1, 1913, p. 28, pl. ii., fig. 10 (*Pleurotoma trailli* Hutton; Cat. Tert. Moll., p. 4, not of Cat. Mar. Moll., p. 11.)
White Rock River.

Surcula, sp.?
Wanganui (3).

Clavatula (*Perrona*) *neozelanica* Suter; T.N.Z.I., xlv., 1913, p. 294, pl. xii., fig. 3.
Lower Gorge of Waipara (Holotype).

Bathytoma albula Hutton; Cat. Mar. Moll., 1873, p. 12.
Petane (3); Awamoa.

Bathytoma haasti Hutton; T.N.Z.I., ix., 1877, p. 595, pl. xvi., fig. 5.
White Rock River (Lectotype); Mount Harris (2).

Bathytoma sulcata Hutton; Cat. Tert. Moll., 1873, p. 4.
Mount Harris; White Rock River; Upper Mohaka River; Waikari (2); Lower Gorge of Waipara.

Bathytoma nodilirata Murdoch and Suter; T.N.Z.I., xxxviii., 1906, p. 284, pl. xxii., figs. 10, 11 (= *Planotoma tuberculata* Kirk; T.N.Z.I., xiv., 1882, p. 409.)
Petane.

Bathytoma cheesemani Hutton; Jour. de Conch., xxvi., 1878, p. 16.
Wanganui (Holotype in Otago Museum).

Genota sp.?
Mount Horrible.

Genota excavata Hutton; T.N.Z.I., ix., 1877, p. 595, pl. xvi., fig. 6.
White Rock River (6).

Genota robusta Hutton; T.N.Z.I., ix., 1877, p. 595, pl. xvi., fig. 4.
White Rock River; Lower Gorge of Waipara.

Mangilia protensa Hutton; T.N.Z.I., xvii., 1885, p. 317.
Petane (Holotype and nine paratypes).
Awamoa (2); Mount Harris (2); Waihao (2).

Mangilia abnormis Hutton; T.N.Z.I., xvii., 1885, p. 316.
Petane (Holotype).

Mangilia dictyota Hutton; T.N.Z.I., xvii., 1885, p. 316, pl. xviii., fig. 8.
Petane (Holotype and four paratypes).

Mangilia leptosoma Hutton; T.N.Z.I., xvii., 1885, p. 328.
White Rock River (Holotype and six paratypes).

Mangilia sinclairii Smith; Ann. and Mag. Nat. Hist. (5), xiv., 1884, p. 320.
Wanganui (13).

Daphnella lacunosa Hutton; T.N.Z.I., xvii., 1885, p. 317.
Wanganui (Holotype).

Daphnella cancellata Hutton; Journ. de Conch., xxvi., 1878, p. 18.
Wanganui.

Daphnella striata Hutton; Cat. Tert. Moll., 1873, p. 5.
Wanganui (Type of *Siphonalia cingulata* Hutton); Petane; Wanganui.

Clathurella sp.?.
White Rock River.

Borsonia rudis Hutton; T.N.Z.I., xvii., 1885, p. 328.
Waihao (Holotype and four paratypes); Otaio.

Borsonia cincta Hutton; T.N.Z.I., xvii., 1885, p. 327.
White Rock River (Holotype and four paratypes).

Fam. Terebridae.

Terebra tristis Deshayes; Proc. Zool. Soc., 1859, p. 306.
White Rock River (2); Wanganui (4).

Terebra costata Hutton; T.N.Z.I., xvii., 1885, p. 315, pl. xviii., fig. 6.
Wanganui (Holotype); Awamoa.

Terebra biplex Hutton; T.N.Z.I., xvii., 1885, p. 327.
Pareora (Holotype); Lower Gorge of Waipara; Tutaekuri River.

Terebra orycta Suter; T.N.Z.I., xlv., 1913, p. 295, pl. xli., fig. 2.
Lower Waipara Gorge (Holotype).

Terebra catenifera Tate; Southern Science Rec., January, 1886, p. 5; Trans. Roy. Soc. S. Austr., xi., 1889, p. 160.
Tutaekuri (Type of *Cerithium bicorona* Hutton).

Fam. Scaphandridae.

Cylichnella striata Hutton; Cat. Mar. Moll., 1873, p. 52.
Petane; Awamoa.

Fam. Tornatinidae.

Tornatina pachys Watson; Journ. Linn. Soc., xvii., 1883, p. 331.
Wanganui.

Volvulella reflexa Hutton; T.N.Z.I., xviii., 1886, p. 333.
White Rock River.

Fam. RINGICULIDAE.

Ringicula uniplicata Hutton; T.N.Z.I., xvii., 1885, p. 313.
Petane.

Fam. ACTAEONIDAE.

Pupa alba Hutton; Cat. Mar. Moll., 1873, p. 51.
Wanganui.

Acteon sulcatus Hutton; T.N.Z.I., xvii., 1885, p. 319, pl. xviii., fig. 15.
Wanganui (Type).

Acteon ovalis Hutton; T.N.Z.I., xvii., 1885, p. 325.
White Rock River (Holotype and two paratypes).

Fam. PLEUROTOMARIIDAE.

Pleurotomaria tertiaria McCoy; Prod. Pal. Vict., Decade iii., 1876, p. 23, pl. xxv., fig. 1.
Mount Somers.

Scissurella mantelli Woodward; Proc. Zool. Soc., 1859, p. 202, pl. xlvi., fig. 8.
Petane.

Fam. FISSURELLIDAE.

Emarginula striatula Quoy and Gaimard; Voy. Astrol. iii., 1834, 332, pl. lxviii., figs. 21-22.
Wanganui.

Subemarginula parmorphoidea Quoy and Gaimard; Voy. Astrol., iii., 1834, p. 325, pl. lxviii., figs. 15, 16.
Wanganui.

Fissuridea monilifera Hutton; Cat. Mar. Moll., 1873, p. 42.
Wanganui.

Fam. SIPHONARIIDAE.

Siphonaria obliquata Sowerby; Cat. Coll. Tankerville, 1825, app. p. 7.
Motunau.

Fam. LITTORINIDAE.

Risella melanostoma Gmelin; Syst. Nat. ed. 13, 1789, p. 3581, No. 90.
Wanganui.

Fam. Conidae.

Hemiconus trailli Hutton; Cat. Tert. Moll., 1873, p. 10.
Awamoa; Point Hill, Waitaki; Broken River.

Conus ornatus Hutton; Cat. Tert. Moll., 1873, p. 10.
Awamoa.

Fam. Amphibolidae.

Amphibola crenata Martyn; Univ. Conch., ii., 1784, fig. 69, p. 335.
(= *Cyclostrema obliquata* Hutton).
Wanganui (Hutton's Type).

Fam. Helicidae.

Therasia decidua Pfr; Proc. Zool. Soc., 1857, p. 108.
Petane (2).

SCAPHOPODA.

Fam. Dentaliidae.

Dentalium nanum Hutton; Cat. Tert. Moll., 1873, p. 1.
Petane (3); Wanganui (4).

Dentalium mantelli Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 45, pl. xiii., fig. 7.
Pareora (2); Waihao (3); Hampden (4); Otaio (3); Motunau (5); Waimea (3); Waikari (2); Porter River; Mohaka River (3); Whangape Lake.

Dentalium solidum Hutton; Cat. Tert. Moll., 1873, p. 2.
Oamaru (3); Whiterock River (3); Mount Harris; Lower Gorge of Waipara.

Dentalium pareorensis Pilsbry and Sharp; Man. Conch. (1), xvii. p. 211 (= *D. laeve* Hutton, *non* Scholtheim, 1820; Cat. Tert. Moll., 1873, p. 2).
Mount Harris (5).

Dentalium ecostatum Kirk; T.N.Z.I., xii., 1880, p. 306.
Wanganui (4); Pareora.

PELECYPODA.

Fam. Nuculidae.

Nucula nitidula A. Adams; P.Z.S., 1856, p. 51.
Petane (2).

Fam. Ledidae.

Leda semiteres Hutton; T.N.Z.I., ix., 1877, p. 598.
Waihao; Wanganui.

Leda bellula A. Adams; P.Z.S., 1856, p. 49.
Wanganui.

Poroleda lanceolata Hutton; T.N.Z.I., xvii., 1885, p. 332.
Petane (Type).

Malletia australis Quoy and Gaimard; Voy. Astrol., iii., 1835, p. 471, pl. lxxviii., figs. 5-10.
Waikari; Mount Harris.

Fam. Anomiidae.

Anomia huttoni Suter; Man. of Moll., 1913, p. 843, pl. lvii., fig. 8. (= *A. alectus* Hutton, *non* Gray).
White Rock River (6); Shrimpton's, Ngarururoro River.

Anomia undata Hutton; T.N.Z.I., xvii., 1885, p. 324 (= *A. cytaeum* Hutton, *non* Gray).
Petane (Type).

Placunanomia incisura Hutton; Cat. Tert. Moll., 1873, p. 34.
Pareora.

Placunanomia zelandica Gray; Dieffenbach's "New Zealand," 1843, p. 260.
Te Ngawai; Glenmark.

Fam. Arcidae.

Arca (*Cucullaria*) *australis* Hutton; T.N.Z.I., xvii., 1885, p. 331.
White Rock River (Type); Double Corner, Lower Gorge of Waipara.

Arca decussata Sowerby; P.Z.S., 1833, p. 18.
Wanganui (3).

Cucullaea ponderosa Hutton; Cat. Tert. Moll., 1873, p. 27.
Porter River; Broken River.

Cucullaea alta Sowerby; in Darwin's "Geol. Obs. on South America," 1846, p. 252, pl. ii., figs. 22, 23.
Waikari River (2); Kakahu (2); Lower Gorge of Waipara; Greta.

Cucullaea attenuata Hutton; Cat. Tert. Moll., 1873, p. 28.
Lake Wakatipu; Collingwood.

Cucullaea sp.
Broken River.

Limopsis zitteli, von. Ihering; Anal. del Mus. Nacion., Buenos Aires, xiv., 1907, p. 235.
Pareora (2); also two specimens without locality indicated.

Limopsis aurita Brocchi; Conch. Foss. Subapenninae, 1814, p. 485, pl. ix., fig. 9.
Otaio (5); Waitaki (4); Mount Harris (3); Waihao (3).

Glycymeris cordata Hutton; Cat. Tert. Moll., 1873, p. 28.
Greta; White Rock River.

Glycymeris modesta Angus; P.Z.S., 1879, p. 418, pl. xxxv., fig. 4.
Shrimpton's, Ngarururoro River; Wanganui.

Glycymeris laticostata Quoy and Gaimard; Voy. Astrol. Zool. iii., 1835, p. 466, pl. lxxvii., figs. 1, 2, and 4-6.
Porter River; Waikari River.

Glycymeris globosa Hutton; Cat. Tert. Moll., 1873, p. 28.
Orari River; The Point, Waitaki; Shingly Creek, Lake Heron; Porter River; Broken River; Kakahu; Lower Gorge of Waipara; Waipara (precise locality not indicated); Pareora (2); Redcliff Gully, Rakaia.

Glycymeris sp.
Broken River.

Fam. Philobryidae.

Philobrya trigonopsis Hutton; T.N.Z.I., xvii., 1885, p. 324.
Petane (Holotype and three paratypes); Wanganui.

Fam. Mytilidae.

Mytilus striatus Hutton; T.N.Z.I., xvii., 1885, p. 332.
Broken River (Type).

Modiolus australis Gray; App. to King's Voy., ii., 1827, p. 477.
Porter River.

Fam. PECTINIDAE.

Pecten beethami Hutton; Cat. Tert. Moll. 1873, p. 31.
White Rock Quarry, North Canterbury; Hawke's Bay (actual locality not indicated); Mount Somers (2).

Pecten delicatulus Hutton; Cat. Tert. Moll., 1873, p. 30 (= *P. diffluxa* Hutton, *l.c.*, p. 31).
Castle Point (right valve); Greta (left valve); Motunau (left valve); Lower Gorge of Waipara; Hundalee.

Pecten sectus Hutton; Cat. Tert. Moll., 1873, p. 30.
Chatham Island (left valve); Chatham Island (right valve); Callaghan's Creek.

Pecten (*Chlamys*) *dendyi* Hutton; T.N.Z.I. xxxiv., 1902, p. 196, pl. viii.
Chatham Islands (Type).

Pecten burnetti Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 51, pl. x., fig. 2.
Castle Hill; Castle Point; Mount Brown.

Pecten polymorphoides Zittel; Reise Novara, Geol. ii., Pal., p. 51, pl. xi., fig. 3.
North Island (actual locality not indicated).

Pecten williamsoni Zittel; Reise Novara Geol. ii., Pal., 1864, p. 50, pl. ix., fig. 11.
Weka Pass; Oxford; Waipara (2); Curiosity Shop (2).

Pecten zelandiae Gray; in Dieffenbach's "New Zealand," 1843, p. 260.
Wanganui (4).

Pecten athleta Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 49, pl. x., fig. 1.
Waikari.

Pecten triphooki Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 52, pl. xi., fig. 4.
Napier (2); Double Corner; Upper Waitotara.

Pecten (*Chlamys*) *hillii* Hutton; T.N.Z.I., xxxvii., 1905, p. 473, pl. xliv., fig. 3.
Napier (Type); Lower Gorge of Waipara.

Pecten semiplicatus Hutton; Cat. Tert. Moll., 1873, p. 30.
Napier.

Pecten hutchinsoni Hector; Cat. Col. Mus., 1870, p. 183, *nom. nud.*; Hutton; Cat. Tert. Moll., 1873, p. 31.
Oamaru; Broken River; Porter River (2).

Pecten accrementus Hutton; Cat. Tert. Moll., 1873, p. 31.
Oamaru (2).

Pecten scandulus Hutton; Cat. Tert. Moll., 1873, p. 29.
Curiosity Shop; Weka Pass (2).

Pecten fischeri Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 53, pl. ix., fig. 1, 2.
Weka Pass.

Pecten (*Pseudamusium*) *huttoni* Park; T.N.Z.I., xxxvii., 1905, p. 485.
Duntroon (Type); Anama; Mount Somers (2); Weka Pass; Kakahu; Curiosity Shop.

Pecten (*Amusium*) *zitteli* Hutton; Cat. Tert. Moll., 1873, p. 32.
Whangape Lake (2).

Pecten medius Lamark; Anim. s. vert., vi., 1819, p. 163.
Wanganui; Waihao. Another specimen occurs, but the locality is not indicated.

Fam. Limidae.

Lima paucisulcata Hutton; Cat. Tert. Moll., 1873, p. 33.
Mount Somers; Broken River; Pareora.

Lima paleata Hutton; Cat. Tert. Moll., 1873, p. 33.
Curiosity Shop (2); Lower Gorge of the Waipara.

Lima colorata Hutton; Cat. Tert. Moll., 1873, p. 33.
Pareora (2); Mount Horrible (2).

Lima bullata Born; Mus. Cæs. Vindobon., 1780, p. 110, pl. vi., fig. 8.
Broken River; Lower Gorge of the Waipara.

Lima (*Plagiostoma*) *laevigata* Hutton; Cat. Tert. Moll., 1873, p. 33.
Opuha; Duntroon; Mount Somers (2).

Fam. Ostreidae.

Ostrea hyotis Linné; Syst. Nat., ed. 10, 1758, p. 704.
Shakespeare Cliff, Wanganui (2).

Ostrea angasi Sowerby; Conch. Icon., xviii., 1871, pl. xiii., fig. 27.
Shrimpton's, Ngaruroro River (2); Wanganui (3); Motunau; Waipara; Kakahu; Waimate.

Ostrea corrugata Hutton; Cat. Tert. Moll., 1873, p. 35.
Waihi River.

Ostrea wullerstorfii Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 54, pl. xi., fig. 6.
Waihao.

Ostrea ingens Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 54, pl. xiii., fig. 3.
Napier; Thames River; Camp Creek; Trelissick?.

Ostrea nelsoniana Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 55, pl. xi., fig. 7.
Waikari River; Orari; Glenmark; Motunau; Lower Gorge of Waipara.

Fam. Pinnidae.

Atrina zelandica Gray; Yates' "New Zealand," 1835, p. 310.
Kakahu (2); Curiosity Shop.

Fam. Pernidae.

Perna sp.
Matapiro, Hawke's Bay.

Fam. Crassatellitidae.

Crassatellites obesus A. Adams; P.Z.S., 1852 (1854), p. 90, pl. xvi., fig. 2 (= *C. trailli* Hutton; Cat. Tert. Moll., 1873, p. 24).
Mount Harris; Wharekuri; Mount Horrible; Pareora; Awamoa.

Crassatellites amplus Zittel; Voy. Novara, Geol. ii., Pal., 1864, p. 46; pl. 14, fig. 3.
Porter River; Lower Gorge of Waipara.

Crassatellites attenuatus Hutton; Cat. Tert. Moll., 1873, p. 24.
Porter River; Point Hill, Waitaki.

Fam. Astartidae.

Astarte australis Hutton; Cat. Tert. Moll., 1873, p. 25.
Kakahu.

Fam. Carditidae.

Venericardia bollonsi Suter; P. Mal. Soc. vii., 1907, p. 211, pl. xviii., figs. 8, 86.
Petane (3).

Venericardia difficilis Deshayes; Proc. Zool. Soc., 1852 (1854), p. 103, pl. xvii., figs. 16, 17.
Tuffs below limestone, Kakanui (2); Shakespeare Cliff, Wanganui (2).

Venericardia australis Lamarck; Anim. sans. Vert., 1818, p. 610. (= *Venericardia awamoaensis* Harris; for *Venericardia intermedia* Hutt., which, however, is *V. australis* Lamarck, identified by Suter after type specimen).
Wanganui; Shepherd's Hut, Waipara; Lower Gorge of Waipara; Porter River (6); Mount Harris (3); Orari (2).

Cardita calyculata Linné; Syst. Nat., ed. 10, 1758, p. 692.
Wanganui (2).

Fam. Lucinidae.

Loripes concinna Hutton; T.N.Z.I., xvii., 1885, p. 323.
Wanganui (Type); White Rock River.

Loripes laminata Hutton; T.N.Z.I., xvii., 1885, p. 331.
White Rock River (Type).

Divaricella cumingi A. Adams and Angas; Proc. Zool. Soc., 1863, p. 426, pl. xxxvii., fig. 20.
Wanganui; Porter River; Pareora.

Fam. Diplodontidae.

Diplodonta zelandica Gray; Yates' "New Zealand," 1835, p. 309.
Kakanui.

Diplodonta globularis Lamark; Anim. sans. Vert., v., 1818, p. 544.
Wanganui (2).

Diplodonta ampla Hutton; T.N.Z.I., xvii., 1885, p. 323.
Wanganui (Type).

Fam. Leptonidae.

Neolepton effossum Hutton; T.N.Z.I., xvii., 1885, p. 323.
Petane (Type).

Neolepton robustum Hutton; T.N.Z.I., xvii., 1885. p. 323.
Petane (Type).

Fam. Tellinidae.

Tellina eugonia Suter (= *T. angulata* Hutton); T.N.Z.I., xvii., 1885, p. 322.
Wanganui (Type).

Fam. Semelidae.

Leptomya lintea Hutton; Cat. Mar. Moll., 1873, p. 67.
Wanganui (Type).

Fam. Mactridae.

Mactra attenuata Hutton; Cat. Tert. Moll., 1873, p. 18.
Porter River (2).

Mactra scalpellum Reeve; Conch. Icon., viii., 1854, pl. xix., fig. 106.
Petane (4); Matapiro, Hawke's Bay; Wanganui (3).

Mactra ovata Gray; in Dieffenbach's N.Z., 1843, p. 251.
Petane (Holotype and five paratypes of *M. lavata* Hutton.)

Mactra chrydaea Suter; T.N.Z.I., xliii., 1911, p. 596, pl. xxxi.
Turangarere (Metatype); Greta.

Mactra (*Mactroderma*) *crassa* Hutton; T.N.Z.I., xvii., 1885, p. 332.
Wanganui (Holotype and one paratype).

Spisula ordinaria E. A. Smith; Pub. Mal. Soc., iii., 1898, p. 23, fig. 7 in text.
Wanganui.

Lutraria solida Hutton; Cat. Tert. Moll., 1873, p. 19.
Ngaruroro, Hawke's Bay.

Zenatia acinaces Quoy and Gaimard; Voy. Astrol. iii., 1835, p. 545, pl. lxxxiii., figs. 5, 6.
Wanganui (2).

Fam. Veneridae.

Chione crassa Quoy and Gaimard; Voy. Astrol., iii., 1835, p. 525, pl. lxxxiv., fig. 7-8.
Wanganui (4); Napier; Motunau; Point Hill, Waitaki.

Chione meridionalis Sowerby; in Darwin's "Geol. Obs. in S. America," 1846, p. 250, pl. ii., fig. 13.
Waikari (2); Greta; White Rock River.

Chione yatei Gray; Yates' "New Zealand," 1885, p. 309.
Porter River.

Chione speighti Suter; T.N.Z.I., xlv., 1913, p. 296; pl. xiv.
Lower Waipara Gorge (Holotype and one paratype. Another specimen from the same locality shows the hinge.

Chione stutchburyi Gray; in Wood's "Index Tert.,"suppl., 1828, fig. 4; Yates' "N.Z.," 1835, p. 308.
Lower Gorge of Waipara (2).

Chione acuminata Hutton; Cat. Tert. Moll., 1873, p. 21.
Pareora (2).

Paphia curta Hutton; Cat. Tert. Moll., 1873, p. 22.
The Point, Waitaki; Porter River (5).

Dosinia magna Hutton; Cat. Tert. Moll., 1873, p. 22.
Porter River (2); Lower Gorge of Waipara (2); Kakahu.

Dosinia greyi Zittel; Reise Novara, Geol. ii., Pal., pt. 2, 1864, p. 45, pl. xv., fig. 11.
Lower Gorge of Waipara; Greta (2). Another specimen, locality not indicated.

Dosinia sub-rosea Gray; in Yates' "New Zealand," 1835, p. 309.
Motunau (3); Lower Gorge of Waipara.

Dosinia lambata Gould; U.S. Expl. Expd., xii., 1850, p. 422, Atlas, fig. 530.
Wanganui (3); Pareora (2); Lower Gorge of Waipara.

Cytherea sub-sulcata Suter (= *Venus sulcata* Hutton); Proc. Linn. Soc., N.S.W. (2), i., 1887, p. 226.
Shrimpton's, Ngarururoro River (Idiotype); Motunau.

Cytherea oblonga Hanley; Wood's Index Tert., suppl., 1828.
Castle Point, Wellington.

Cytherea enysi Hutton; Cat. Tert. Moll., 1873, p. 21.
Porter River (2).

Macrocallista assimilis Hutton; Cat. Tert. Moll., 1873, p. 21.
Porter River (2); Wanganui; Point Hill, Waitaki.

Macrocallista multistriata Sowerby; Thes. Conch., ii., 1851, p. 628, pl. cxxxvi., fig. 177.
Motunau (2); Lower Gorge of Waipara.

Meretrix sp.
Clent Hills Station.

Fam. Cardiidae.

Cardium spatiosum Hutton; Cat. Tert. Moll., 1873, p. 23.
Broken River; Porter River; Lower Gorge of Waipara.

Cardium huttoni von. Ihering; Anal. del Mus. Buenos Aires, xiv., 1907, p. 291 (= *C. multiradiatum* Hutton; not of Sowerby).
Double Corner, Lower Gorge of Waipara.

Cardium patulum Hutton; Cat. Tert. Moll., 1873, p. 23.
Porter River; Lower Gorge of Waipara.

Cardium (*Fragum*) sp.
Weka Pass Stone; Waikari Valley.

Hemicardium sp.?
Ormond, Poverty Bay.

Protocardium serum Hutton; Cat. Tert. Moll., 1873, p. 23.
Broken River.

Fam. PSAMMOBIIDAE.

Psammobia lineolata Gray; Yates' "New Zealand," 1835, p. 309.
Wanganui; Waitaki (2).

Soletellina nitida Gray; Dieffenbach's "New Zealand," 1843, p. 253.
Pareora.

Fam. CORBULIDAE.

Corbula pumila Hutton; T.N.Z.I., xvii., 1885, p. 330.
White Rock River (Type).

Corbula macilenta Hutton; Cat. Tert. Moll., 1873, p. 18.
Wanganui (3).

Corbula canaliculata Hutton (= *C. sulcata* Hutton); T.N.Z.I., ix., 1877, p. 598, pl. xvi., fig. 14.
Mount Harris (Lectotype).

Corbula humerosa Hutton; T.N.Z.I., xvii., 1885, p. 330.
White Rock River (Type).

Fam. SAXICAVIDAE.

Panopea zelandica Quoy and Gaimard; Voy. Astrol., iii., 1835, p. 547, pl. lxxxiii., figs. 7-9.
Watakuhi, Bay of Islands; Pareora; Motunau.

Panopea orbita Hutton; Quart. Journ. Geol. Soc., xli., 1885, p. 551 (= *P. plicata* Hutton; Cat. Tert. Moll., p. 17).
Pareora; Mount Harris; Greta; Lower Gorge of Waipara.

Panopea worthingtoni Hutton; Cat. Tert. Moll., 1873, p. 17.
Lake Wakatipu (2).

Fam. TEREDINIDAE.

Teredo heaphyi Zittel; Reise Novara, Geol. ii., Pal., 1864, p. 45, pl. xiv., fig. 4 (= *Cladopora directa* Hutton; T.N.Z.I., ix., 1877, p. 597, pl. xvi., fig. 13).
Waihao; Te Ngawai; Curiosity Shop; White Water River, Trelissick.

Fam. THRACIIDAE.

Thracia vitrea Hutton; Cat. Mar. Moll., 1873, p. 61.
Wanganui.

Fam. MYOCHAMIDAE.

Myodora novae-zealandiae E. A. Smith; Proc. Zool. Soc., 1880, p. 584, pl. liii., fig. 5.
Wanganui.

Myodora subrostrata E. A. Smith; Proc. Zool. Soc., 1880, p. 584, pl. liii., fig. 6.
Awamoa (5).

Myodora boltoni E. A. Smith; Proc. Zool. Soc., 1880, p. 585, pl. liii., fig. 9.
Matapiro, Hawke's Bay.

Myodora antipodum E. A. Smith; Proc. Zool. Soc., 1880, p. 585, pl. liii., fig. 7.
Wanganui.

Myodora striata Quoy and Gaimard; Voy. Astrol., iii., 1835, p. 537, pl. lxxxiii, fig. 10.
Wanganui (2).

Pholadomya sp.?
Porter River.

Fam. CHAMOSTREIDAE.

Chama huttoni Hector; Outline of the Geology of N. Zealand, 1886, p. 50, fig. 7, no. 7.
Castle Point, Wellington.

Chamostrea albida Lamarck; Anim. sans Vert., ed. 2, vi., 1819, p. 96.
Porter River; Wanganui.

CEPHALOPODA.

Fam. NAUTILIDAE.

Aturia aturi var. *australis* McCoy; Ann. Mag. Nat. Hist. ser. 3, xx., 1867, p. 192.
Double Corner, Lower Gorge of Waipara; Weka Pass.

Fam. BELEMNITIDAE.

Belemnites lindsayi Hector.
Waitaki Valley (7).
The status of this species is, at the request of Professor Park, being considered by Dr. F. A. Bather.

DESCRIPTIONS
OF
TWO NEW MARINE SHELLS
FROM
NEW ZEALAND

By Henry Suter.

Figures 1 and 2.

Having lately overhauled and rearranged the collection of recent mollusca in the Canterbury Museum, I found two unnamed marine species, which prove to be new to science. They are described and figured below :—

Siphonium planatum sp. nov.

Fig. 1

Shell very small, adherent planorbiform, sinistral, the lower volutions somewhat irregular, the upper ones spirally wound up, the apex subcentral. *Sculpture*: the whorls are distinctly angled, and ornamented with close sinuous transverse ridges. *Colour*, white. *Whorls* 8 to 10, narrow. *Suture* well marked. *Aperture* triangular or quadrangular, without internal armature. *Operculum* not seen.

Dimensions.—Diameter maj. 10 mm., min. 8·5; height 4 mm.; diameter of aperture 1·2 mm. (Holotype).—Diameter maj. 8·5 mm., min. 8 mm.; height 5 mm.; diameter of aperture 1 mm. (Paratype).

Holotype and 1 *paratype* in the Canterbury Museum, Christchurch.

Hab.—Kapiti Island.

Remarks.—This species very much resembles *S. politum* Daudin, from the Indian Ocean[17]. Quite recently it has been discovered in the Miocene of the Trelissick Basin, and at Oamaru.

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(17) Man. Conch (1), viii., 1886, pl. liv., fig. 85.

TROPHON VIRGINALIS sp. nov.

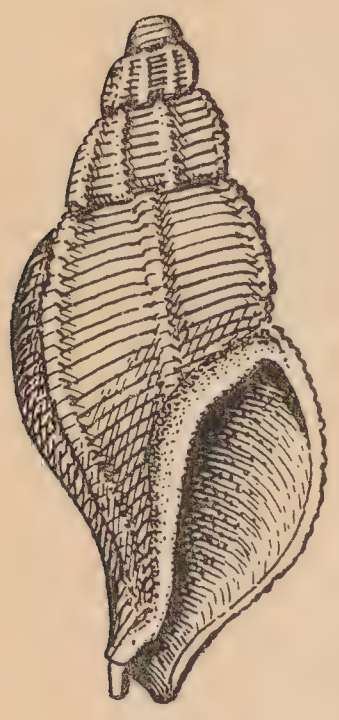

Fig. 2

Shell rather small, white, fusiform, with distant rounded varices, and close spiral cords. *Sculpture* consisting of rounded, distant varices, 5 on the body-whorl, 9 on the penultimate whorl, mostly discontinuous over the whorls; interspaces with close and fine axial riblets; spiral sculpture formed by close cords, 12 on the penultimate whorl, passing over the varices; slightly gemmulate at the intersection with the axial riblets; sometimes with a fine thread intercalated between the cinguli. *Colour*, white, semi-transparent. *Spire* narrowly conical, about the same height as the aperture with canal. *Protoconch* missing. *Whorls* about 5, convex, somewhat flattened below the suture, the body-whorl slightly ventricose, contracted at the base. *Suture* not much impressed. *Aperture* subvertical, oval, angled above, produced below into a short open canal, which is slightly turned backwards and to the left. *Outer lip sharp,* strengthened on the outside by a varix, convex above, but slightly concave towards the canal. *Columella* straight, lightly truncated below. *Inner lip* thin, broadly spread over the body, free at its lower part, leaving a narrow chink between it and the distinct siphonal fasciole. *Operculum* unknown.

Dimensions.—Height, 16 mm.; diameter, 7 mm.; angle of spire, 38°.

Holotype in the Canterbury Museum, Christchurch.

Hab.—Cape Maria van Diemen.

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THE HABITAT AND LIFE HISTORY OF *LIOPELMA HOCHSTETTERI*

By Gilbert Archey, M.A., Assistant Curator.

(Plates IX. to XII.).

Historical.

Renewed interest has been taken in the New Zealand native frog since the discovery, by Mr. H. Hamilton, of a new species, *Liopelma hamiltoni*, McCulloch (1919, p. 447) on Stephen Island. Of *Liopelma hochstetteri*, described in 1861 by Fitzinger, little has been recorded beyond the discovery of specimens from time to time in different parts of the Coromandel Peninsula.

The first record of frogs in New Zealand is the rather ornate and unconvincing account given by Polack (1838, i., p. 318), who describes their "barometric croak" on the approach of rain, and the discomfort experienced by "these hydromancers" in the rainy mountain districts. In Dieffenbach's "New Zealand" (1843, ii., p. 206) Polack's account is referred to, but Dieffenbach states that he had seen no specimens. Ten years later Dr. A. S. Thomson (1853) published the first authentic account of the discovery of native frogs, which were found among boulders in the bank of a creek at Coromandel. This paper was reprinted in the New Zealand Journal of Science and Technology in January last year. An interesting fact mentioned by Thomson is that the Maoris in Coromandel, or elsewhere, were quite ignorant of the existence of a frog in New Zealand, and were unable to give a name to the creature when they saw it.

Fitzinger described *Liopelma hochstetteri* in 1861 (p. 218, pl. 6), his description was reprinted by Steindachner (1869) in the "Zoology of the Voyage of the 'Novara,'" and afterwards a translation by Captain Hutton (1880, p. 250) appeared in the Transactions of the New Zealand Institute.

W. A. Aiken (1870), in recording the occurrence of a frog at Puriri, eight miles south of Thames, stated that it was taken from one of the range creeks about 500 feet above the level of the Thames River, above a series of steep water-falls in the creek.

Last year Mr. S. Percy Smith (1921, p. 308) described the discovery of several specimens on the Tokatea ridge "under loose

stones on the crest of the range, moss-covered, and damp from the elevation." He also mentioned that the Maoris knew of the frogs only by report of Dr. Thomson's discovery. Dr. J. Allan Thomson (1921, p. 308) in a footnote to Mr. Percy Smith's paper, remarked that he had been unable to find *Liopelma* around Coromandel or Opitonui, but that it was known to be living among the moss on the upper slopes of Mt. Moehau. Generally, one may gather from the published records that the frog is rare, so rare that the Maoris knew nothing of it, and that its habitat is the wet moss or debris near the hill streams; one must note, however, that Mr. Percy Smith found the animals under stones on the crest of the Tokatea ridge.

Habitat.

The discovery of *Liopelma hamiltoni* on Stephen Island, from which the surface water disappears in summer, made it clear that the species had a modified life-history. Dr. Allan Thomson suggested that *Liopelma* might be viviparous, and Mr. Charles Hedley (1919, p. 449) in a footnote to McCulloch's description of *Liopelma hamiltoni*, drew attention to the fact that many interesting modifications in the development of frogs may occur, "such as is exhibited by the Australian *Pseudophryne*, of which the hatching of the ova may be postponed for a period of at least three months when dry conditions prevail."

Last year, in order to secure specimens of *Liopelma hochstetteri* for the Museum, Professor Speight wrote to Dr. T. A. Black, then resident in Coromandel, who very kindly made our requirements widely known, and asked those who knew of the frogs to communicate with the Museum. Among the correspondence that followed was a letter from Mr. J. D. Regan, of Coromandel, who stated that he had seen the eggs "with young frogs swimming in them like fish." The life-history of *Liopelma* thus promised to be of more than usual interest, and it was therefore arranged that the writer should visit Coromandel to secure specimens of the frogs, and, if possible, to obtain eggs and tadpoles. Meanwhile the Animals Protection Act had been extended to cover *Liopelma*, but necessary authority to obtain specimens was granted by the Department of Internal Affairs.

Accordingly I visited Coromandel in November last, spending four days there, and made as thorough a search as the time allowed over an area on the range immediately behind the town. During my stay at Coromandel I received much kindly assistance and valuable information from Mr. F. C. Horne, Mr. J. D. Regan, and Mr. J. Stuart McNeil. Mr. Regan, who has spent thirty years prospecting on the ridges, informed me that he had occasionally seen native frogs during the past fifteen years. The eggs which he referred to in his letter were discovered ten years ago, and he

had seen other eggs on two subsequent occasions. Mr. Horne had seen the frogs frequently during the last ten years, and could usually find them when he wished to do so, and Mr. McNeil, who also had found them not infrequently, had seen the eggs once. These gentlemen gave up a considerable amount of valuable time in order to conduct me to places where the frogs could be found and to assist in securing them, and I wish to place on record my sincere appreciation of and cordial thanks for their kindly assistance and help.

The Tokatea ridge, which was the area searched, rises up steeply to the north-east of the township of Coromandel, and reaches a height of about 2,000 feet. The western face of the ridge, overlooking the town, has been, for the most part, cleared of bush and repeatedly burnt, but on the eastern slope only the larger trees have been taken out, and there remains a good covering of moderate-sized bush, which ends abruptly right on the crest of the ridge. The road from Coromandel to Kennedy Bay crosses the ridge at the Tokatea Saddle, and from this point to Mr. Horne's summer whare, about four miles northward along the ridge, search was made on November 12th in company with Mr. Horne.

At the side of the grassy bridle track, which runs along the crest, were small logs and the uprooted stumps of small trees; the first one of these turned over by Mr. Horne proved to be the shelter of a small frog, whose mottled green and brown coloration made it almost indistinguishable from the debris underlying the log. A few minutes later I found a very small predominantly green specimen among dripping moss in an abandoned prospecting drive, the only one found in this kind of situation. Thereafter almost every log proved to be the shelter of two or three individuals, and it was noted that they seemed to occur less frequently within the bush on the eastern face of the ridge than under the logs on the grassy western face. This may have been due to the broken light of the bush rendering their concealing coloration more effective, but one was able to make a quite thorough examination of the ground, and feels sure that few were overlooked. One had always understood that *Liopelma* was to be found under the moss covering dripping or trickling falls, but here they were frequenting the open ridges, and Mr. Horne informed me that nearly all the specimens he had found from time to time were seen on the ridge, but that they were rarely obtained in or near the creek beds. At the time of my visit there was practically no surface water within 300 feet of the crest, so the presence of the frog here in what is normally the breeding season indicated a certain degree of independence of water.

Later in the same day, while the eastern (wooded) face of the crest was being searched there was found under a small log, about five yards from the crest, a frog sitting over a cluster of eggs. The

eggs were in two groups of six each, each group being covered by a membrane enclosing a gelatinous transparent mass, in which the yellowish partly developed eggs could be seen. A few minutes later another frog was found with eggs, this time there being six eggs in two groups of three. They were in a more advanced state of development than those previously found, and when the eggs were disturbed the developing embryos could be seen to rotate slowly. The first day's collecting had therefore shown that *Liopelma hochstetteri* was by no means so rare as had been supposed, and also that its life-history presented another example of the many modifications that are known in the metamorphosis of the Anura. The detailed description of the eggs and their development appears in a later portion of the paper.

The following day, in company with Mr. McNeil, a traverse was made of the spurs and valleys about 600 feet from the crest, the purpose being to ascertain whether the frogs descended so far down the ridge, and whether they occurred in the creek beds. The part selected was on the western side of the ridge, where there were bare or grassy spurs, and valleys with bush extending some way on either side of the creeks. Search was also made along the course of a stream up as far as a steep dripping cliff, its source for the time being. Only one frog was found during the day, and this was among some debris at the side of the cliff just mentioned. It was an extremely dark specimen, no green colour showing, the pattern of the mottling present on ordinary specimens being indicated by darker brown marks and bands.

The third day was occupied in examining the ground along the inland Cabbage Bay* Road as far as the saddle at the head of the Cabbage Bay Valley; a switch from the main Tokatea ridge meets the saddle here, and Mr. Horne's whare is situated on this switch spur (Plate IX.). No frogs were found until one approached the whare, and then they were found in situations similar to those on the Tokatea ridge. The last day was devoted to an attempt to secure more eggs, and, with Mr. Regan, I visited the Tokatea Saddle again. Two further clusters of eggs, each with an accompanying frog, were found, one in a remarkably dry and open situation under a flat stone. The eggs in the other cluster were well advanced in development, a slight disturbance of the gelatinous mass being sufficient to set the embryos energetically circling over and over within their capsules.

The observations of those who have, for many years, spent the greater part of their time upon the Coromandel hills, and the results of the brief search made by the writer indicate that the natural habitat of *Liopelma hochstetteri* is to be found, not in the valleys and stream beds, but high up on the open spurs and the crest of

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* The name has recently been changed to Colville Bay,

the ridge. Mrs. Chester Curtis, of Cabbage Bay, who is familiar with the habits of the frog on Mt. Moehau, in the north of the Peninsula, has informed me that there also it is found on the higher slopes of the mountain. Mr. Horne suggested, in explanation of this, that the fogs and mists which prevail on the hill-tops might account for this restriction. He has found that, in the height of summer, when the lower hills and valleys are parched, and the streams are dry in their upper courses, the sea mists, which are continually driven over the crests, provide enough moisture to maintain a sufficient growth of grass for his stock ; this prevailing dampness would therefore be sufficient for the well-being of the frogs. In this connection it is interesting to note the fact that *Liopelma hamiltoni*, of Stephen Island, is also found high up on the hill forming the centre of the island, occurring there under large heaps of stones. Mr. W. R. B. Oliver, who has just returned from a visit to Stephen Island to obtain specimens, writes :—" All the specimens were taken under and among heaps of stones, a foot or so from the surface. They were usually on the ground, which was somewhat damp under the stones. The locality was a patch of bush near the summit of Stephen Island, altitude 950 feet. The climate is that of Cook Strait, that is, subject to severe winds, often with much rain and cold." Mr. P. Malthus, until recently principal light-keeper on Stephen Island, tells me that the hill is frequently covered by mists during the hotter part of the year, when there is no surface water on the island.

The occurrence of these two closely related species in similar situations so far separated suggests that search on the mist-covered hills may reveal their presence in other parts of the country, as, for example, on the main chain of mountains of the North Island, or on Great Barrier Island or the hills of the North Auckland Peninsula. The fact that these frogs have hitherto been searched for in mossy creeks, rather than upon the heights, makes it not unlikely that their presence elsewhere has been overlooked.

Geographical Distribution.

The Discoglossidæ are probably the oldest of the tongued Anura, and their sparse disconnected distribution has been considered recently by Stejneger (1905 a.) and Hedley (1919). They are known in eastern and south-eastern Asia, Europe, western North America (*Ascaphus*) and New Zealand, and this distribution (excepting New Zealand) agrees roughly with that of the related Pelobatidæ. In the fossil state the group is known only from the upper and middle Miocene of Europe, while the Palæobatrachidæ are also from Miocene Europe. Stejneger (1905 a, p. 92) considers that the Discoglossidæ originated in south-eastern* Asia, and radiated

* Misprinted " south-western " in Stejneger's paper, and later corrected by him (1905 b, p. 502)

thence to New Zealand in Cretaceous times, while during the upper Cretaceous they reached the Pacific coast of North America over the land bridge, which then connected eastern Asia with North America, whence they radiated to Europe. Hedley, however (1919, p. 449) considers that "central Asia can have had no relations or direct communication with New Zealand," and suggests that, since the mass of Australian Amphibia arrived there from South America, *Liopelma*, whether originally Asiatic or Neotropical, had a similar history. "Together both the frog faunas of Australia and of New Zealand might have arisen in South America, both escaped by a southern outlet—the one to New Zealand, the other to Australia—and by the eastern door of 'Arch-helenis' both may have been admitted to the Mediterranean region by way of north-west Africa, and thence to Asia." Hedley, in referring to Central Asia, may have been misled by the misprint in Stejneger's paper, for there is faunistic evidence, other than the distribution of the Discoglossidæ, of pre-tertiary communication between New Zealand and south-eastern Asia, so that *Liopelma* could have come to this country from the north. Apart from this, however, the suggestion of a southern distribution of the Discoglossidæ, implied in Hedley's statement quoted above, is of interest, and one may perhaps be permitted to consider how the evidence afforded by the distribution of the Anura bears upon it.

The palæontological evidence is scanty, and does not go back beyond the Eocene, when we find a representative of the Ranidæ in Europe. As the Ranidæ are the highest Anura, and as they are at the present time practically restricted to the Northern Hemisphere and Africa, there is no difficulty in assuming that the distribution of the more primitive families in the southern hemisphere took place in pre-tertiary times.

The Hylidæ and Cystignathidæ, so abundantly represented in South America and Australia are probably Notogæan in origin, but the latter family is unrepresented in Europe and Asia, and has only one representative in southern North America, while the former, which is moderately represented in North America, has few species in Europe and Asia.

But in Africa these families are represented only by *Hyla* in the extreme north and Abyssinia, and by *Heleophryne* in the south. If "Arch-helenis" had been the means of transference from South America, it would be expected that a fair body of the migrants would be found in Africa, instead of the solitary genus of each family actually known. North America, which is better represented in Hylidæ, seems therefore a more likely passage-area for the family than Africa.

The Engystomatidæ are known from South America, North America (only one southern species), Africa, Australia and India;

but not from Europe nor from northern and eastern Asia. If we assume that they have reached Africa across "Arch-helenis" we are then faced with the fact that they have only reached the Indian region, and not those parts of the palæarctic wherein the Hylidæ, Pelobatidæ and Discoglossidæ are found. Africa, therefore, does not seem to have been a source of supply for the palæarctic region generally.

Returning to the Discoglossidæ **, we find no evidence that they are, or ever have been in South America, and if they should be found in northern South America the discovery would scarcely affect Stejneger's theory. Should, however, a discoglossoid be discovered in southern South America, a theory of an Antarctic distribution of *Liopelma* to New Zealand might have equal weight with a theory of migration from south-eastern Asia, but the evidence at present before us is in favour of the latter.*

Life History.

The four lots of eggs and the frogs found with them were kept in order to watch further development. Unfortunately, during the journey from Coromandel to Auckland, a lurch of the vessel, or some other cause, resulted in the bag containing the frog-tins being overturned and I was not made aware of this until someone found frogs hopping about the saloon floor. It was found that none of the lots of eggs now had an accompanying frog, so it is impossible to say whether it is the male or female which watches over the eggs.

The eggs which occurred in clusters of three or six (two or three clusters being found in each case) were found under a log or stone in only slightly damp places far removed from surface water. Each cluster was surrounded by a soft transparent gelatinous envelope, the outer portion of which formed a thin membrane. It was found that each egg had its own individual capsule within the

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**Uncertainty has been expressed as to whether *Liopelma* is really a discoglossid, but McCulloch's description and drawing of the pectoral girdle, and his mention of the presence of ribs (p. 448) make the matter clear. It may be added that all the vertebræ are opisthocœlous, and there are nine presacral. [Since going to press a letter has been received from Mr. G. K. Noble, of the American Museum of Natural History who has recently examined the musculature of *Liopelma*, and who states that "it agrees with *Ascaphus*, and differs from all other discoglossids in possessing two 'tail-wagging' muscles, homologous to those in the salamander. Therefore, it appears that *Ascaphus* and *Liopelma* represent the two most primitive Salientia in the world, at least, in regard to their femoral musculature."]

*Noble (Bull, A.M.N.H., vol. 46, pp. 1-87, 1922) has recently separated a group of the South American Engystomatidæ, placing them with the Bufonidæ (including Cystignathidæ), and Hylidæ in the sub-order Procoela. He considers that the southern land masses have been separately stocked from the north, and that trans-atlantic and antarctic land bridges are unnecessary to explain the distribution of the Salientia.

common mass, and that it was possible to separate the eggs. They were, however, left in their clusters, except when an egg was required for preservation, for I had not a great deal of material and did not wish to run the risk of increasing a problematic mortality rate among the embryos. As it was several of the eggs failed to develop, for what reason is not known, but the others carried on the development to some time past the hatching stage.

Each egg is surrounded by a triple capsule enclosing a clear watery fluid; as development proceeds the inner capsules appear to be dissolved, and the amount of water within the capsule greatly increased. In all the eggs collected some degree of development had already taken place, and the number of days that had elapsed since the time of oviposition is unknown. Consequently it is not possible to give accurately the number of days' development represented by each stage described hereunder. It will be understood, therefore, that the number of days given in these stages is only an approximation based on a comparison of the state of the embryos when found, with their subsequent development.

Briefly, the life history is as follows:—The egg has a large spherical yolk-mass, on which the embryo develops. The head, with prominent eyes, the legs and a long tail are soon produced, but there are no gills, respiration being no doubt effected by the vascular tail. Hatching takes place in a little over a month's time, the young frog emerging with a long tail, which is gradually absorbed. At an early stage in the intra-capsular development, the embryo is capable of movement, and as time goes on it becomes fairly active, rotating rapidly by means of movements of its long tail. At the end of about two months the yolk sac is nearly absorbed. Details of the various stages are given hereunder:—

1.—About 7 days (Pl. X., fig. 1).

This is the first stage observed, and already a considerable degree of development has taken place. The embryo is raised up from the yolk sac, the head and tail being free, but no trace of a fin is yet developed on the latter. On the under surface of the anterior part of the head a wide shallow depression represents the mouth. The position of the eyes is indicated by a swelling on each side of the head, and a pair of larger swellings a little further back are the rudiments of the fore-limbs. There is no trace of the hind-limbs, and no movement of the embryo was detected.

2.—14 days (Pl. X., fig. 2).

The body is now longer, the head more definitely formed, the tail projects freely from the yolk-sac, and is provided with a delicate membranous fin. The hind limbs are still not visible. The embryo is semi-transparent when alive, but a faint pigmentation is

visible on the body, and the eyes are strongly marked. The lower surface of the yolk-sac is slightly wrinkled. The embryo now has the power of twisting or wriggling round, and will do so fairly actively if the eggs are disturbed. For convenience I propose to call all the later active stages "larvæ" rather than "embryos."

3.—20 days (Pl. XI., fig. 1).

This stage is marked by a more frog-like form of the head and the appearance of the rudiments of the hind limbs. The eyes are prominent and the nostrils clearly visible, while the mouth is a well-marked crescent depression, but not yet bounded by definite lips. A transverse membranous fold or collar extends across the throat, projecting slightly forward; its function may be respiratory but it is not vascular at any stage in development. The fore limbs project freely forward, but exhibit no detailed structure, while the hind limbs are represented by swellings just anterior to the origin of the tail. The larva, when wrapped round the yolk-sac, extends around two-thirds of its circumference.

4.—24 days (Pl. XI., fig. 2).

The still semi-transparent but slightly pigmented larva of this stage was curled around the yolk-sac while within the capsule. When it was extracted from the capsule, and transferred to a watch-glass containing ordinary artesian water, it immediately straightened out, becoming, at the same time, slightly cloudy, and was apparently dead. After a few minutes, however, it regained its activity, and adjusted itself to its new environment. It developed in eleven days to the stage next described, when it was accidentally destroyed. Its rate of development during its stay in the watch-glass was much slower than that of individuals inside their capsules, for it took eleven days to accomplish in development what was done by other larvæ in four days.

The stage is marked by a considerable increase in the size of the tail and hind limbs, the former being now slightly longer than the head and body. The hind limbs are pear-shaped bodies, lying on either side of an elevated median anal papilla or ridge. The slowly beating heart can be detected just behind the gular fold mentioned in the last stage. The yolk sac has three sinuous and branching blood-vessels, and a long ventral vessel passes along the tail, giving off branches to its surface. The absence of gills, and the presence of this long, vascular, and otherwise useless tail, indicate that the latter is the respiratory organ of the larva, as is the tail of the larva of *Hylodes martinicensis* (Bavay, 1873). This liberated larva, if touched, would wriggle actively about, but there were no definite strokes of the tail, such as would propel it forward. Length—15 mm. (head and body, 6.5 mm., tail, 8.5 mm.).

5.—27 days (Pl. XII., fig. 1).

At this stage the pigmentation has spread over the upper part of the head and over the body, but there is no trace of pigment on the tail, which is still very vascular, and has the membranous fins well developed. The gular fold is fairly large, the heart beats strongly, and the vascularisation of the yolk-sac is more extensive. The form of the limbs is now beginning to be apparent. In the fore limb the distinction between the joints is vaguely indicated, while delicate blood-vessels indicate the outline of the four fingers, and a vessel also runs round the periphery of the hand. The hind limbs, which have been growing strongly, are now considerably longer that the fore limbs, the joints are clearly marked and blood vessels outline four fingers as in the fore limb. The anal papilla still stands out prominently. The lips are now defined though the mouth is not closed ; but, while the specimen was being observed in a watch-glass before preserving, it was noticed that the lips were capable of slight movement. Length, 17.5 mm. (head and body, 7.0 mm., tail, 10.5 mm.).

6.—35 days (Pl. XII., fig. 2).

This stage was observed on the 15th of December, just before hatching. The reduction of the yolk-sac, and the further development of the head now combine to give the larva a more frog-like form ; the pigmentation hitherto black has now a bluish tinge, especially on two broad bands which pass from the nostrils over the eyes, and then sub-medianly along the back. The under surface of the yolk-sac, on which the blood-vessels are now less visible, is also pigmented. The gular fold is still strongly developed. On the top of the head is a broad ridge, while a narrow, more abruptly marked ridge extends backwards from behind each eye, fading out behind the level of the origin of the fore limbs. The latter are quite distinctly divided into their parts, while the hind limbs, which are twice as long as the fore limbs, are pigmented, and have all five toes separated. The anal papilla is now no larger than at the last stage, and is therefore relatively smaller, and from this stage becomes less and less distinct. Length, 20.5 mm. (head and body, 8 mm. ; tail, 12.5 mm.).

7.—Hatching.

Several individuals hatched out on December 16th and on subsequent days. In most of those observed the tail was the first part to slip out, but in one case the head was extruded first. Hatching seemed to be a very slow process, for the young frogs lay in the fluid, which ran out of the capsules for nearly twenty-four hours, before getting completely clear of the membranes. It was not until another eight or ten hours that they showed any inclination to move

about, when they climbed slowly and laboriously among the moss under which they had been lying. Some transferred themselves from the moss to the sides of the glass jar, to which they adhered by flattened feet and abdomen. Within a day of hatching the green colouring began to develop, first as a stippling between the snout and the eyes, and an ill-defined band from behind the eye over the base of the fore limb to half-way along the side ; a slight ridge arises confluent with this band. All the surface blood-vessels now disappear, except the median caudal vessel which remains distinct, but has no branches apparent on the surface of the tail. The fin on the tail almost immediately loses its definite outline. The yolk-sac is still well developed, and the young frogs seem to have no desire to look for or take any food.

Several of the young frogs died soon after hatching, why is not known, for their conditions were the same as those of the majority which survived ; shortly after hatching, a fungus, which appeared very quickly, killed several others. The following details were observed in those which survived.

After a fortnight's free existence the tail is reduced to considerably less than the length of the extended hind limbs, and the jugal collar and anal papilla are much reduced, while the yolk-sac is covered with pigment except for a narrow median band. Within a month after hatching, when the tail is less than two-thirds as long as the body, the yolk-sac is practically absorbed, while the jugal collar has almost disappeared. The whole body is nearly uniformly bright green in colour, and some of the green pigment has extended even to the reduced tail. Aphides were given to the frogs for food, but were untouched, and the last surviving individual, which was very sluggish, was preserved before the fungus might attack it. (Plate XII., fig. 3).

Conclusion.

Several species of Anura of different families have secured partial or complete independence of surface water by modifications somewhat similar to that of *Liopelma hochstetteri*, and afford striking illustrations of convergent evolution in response to the conditions experienced in similar environments. The degree of modification ranges from that presented by *Phyllomedusa jheringi*, where the eggs are laid in between leaves overhanging a pool, the tadpoles slipping down into the water when hatched, to the complete independence of water first described for *Hylodes martinicensis* from the West Indies, and later for *Rana opisthodon* from the Solomon Islands. The intra-capsular form of *Liopelma* differs in some respects from that of *Hylodes martinicensis* which has well-developed vascular gills as well as a respiratory tail, which are, however, both absorbed before hatching (Bavay, 1873). *Rana opisthodon* (Boulen-

ger, 1890, p. 51, pl. 10) seems to have neither tail nor gills during its intra-capsular development, " but on each side of the abdomen are several regular transverse folds . . . the function of which is probably that of a breathing organ."

In considering the development of the modification presented by *Liopelma*, and taking into account the climatic conditions which prevail over its area of distribution, one perceives that it is not necessarily a modification brought about by drought conditions as generally understood; but, on the contrary, it is the considerable precipitation and continued dampness of its habitat which have enabled this independence of surface water to be evolved. On the narrow Coromandel Peninsula there are, in respect to surface water, three zones which become manifest in the summer. They are, first, the low-lying valleys and narrow coastal plain, where, in the driest summer when fields are parched, streams of water are to be found, well suited at the present time to support a frog fauna, as the hearty croakings of the introduced *Hyla aurea* testify; second, a zone from about 1,000 to 1,500 feet high, where, in summer, the upper courses of the streams are dry, as also are the hill-spurs, an area ill-suited to the well-being of frogs; and third, the damp mist-swept hill tops moist enough all the year round for frogs to live there in comfort. I was not able to obtain information as to whether *Liopelma* descends to a lower level in winter, when rains make the surface water more extensive on the area. If one assumes a period when the area of the present peninsula experienced a greater precipitation than now (and the greater elevation of earlier times, which the geological evidence indicates would produce such a precipitation) one might then rely upon a more general distribution of *Liopelma* over the area. A decrease in the annual rainfall would then create the three zones I have mentioned, and would thus divide the frog fauna into two groups, highland and lowland. The disappearance of the lowland forms could be accounted for by the depredations of natural enemies, of which company the weka was probably a formidable member, while frogs of the highland group, being cut off from access to surface water, would have been able, on account of the perpetual dampness of their habitat, to deposit their eggs on the moist earth, where they would have developed. Or the modification may have developed from a habit similar to that of *Alytes obstetricans*, the " midwife-toad " of Europe, where the male carries the eggs attached to his hind legs, occasionally jumping into the water to moisten them, the tadpoles ultimately hatching out in the water. A lengthening of the period of carrying or of caring for the eggs might be induced by a lack of surface water, finally resulting in complete development within the egg-capsule. Finally however, whether *Liopelma* has become restricted to its present hill-top habitat by the depredations of natural enemies, or by partial drought conditions over its area of distribution, it seems that the

conditions which have combined to bring about its present life history are the continuous dampness and lack of surface water over its area. It is not known whether *Liopelma hamiltoni* has a similar life history, but the similarity of its habitat to that of *L. hochstetteri* makes it not unlikely.

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EXPLANATION OF PLATES.

Plate IX.

The habitat of *Liopelma hochstetteri*, the northern end of Tokatea Ridge, Coromandel.

Plate X.

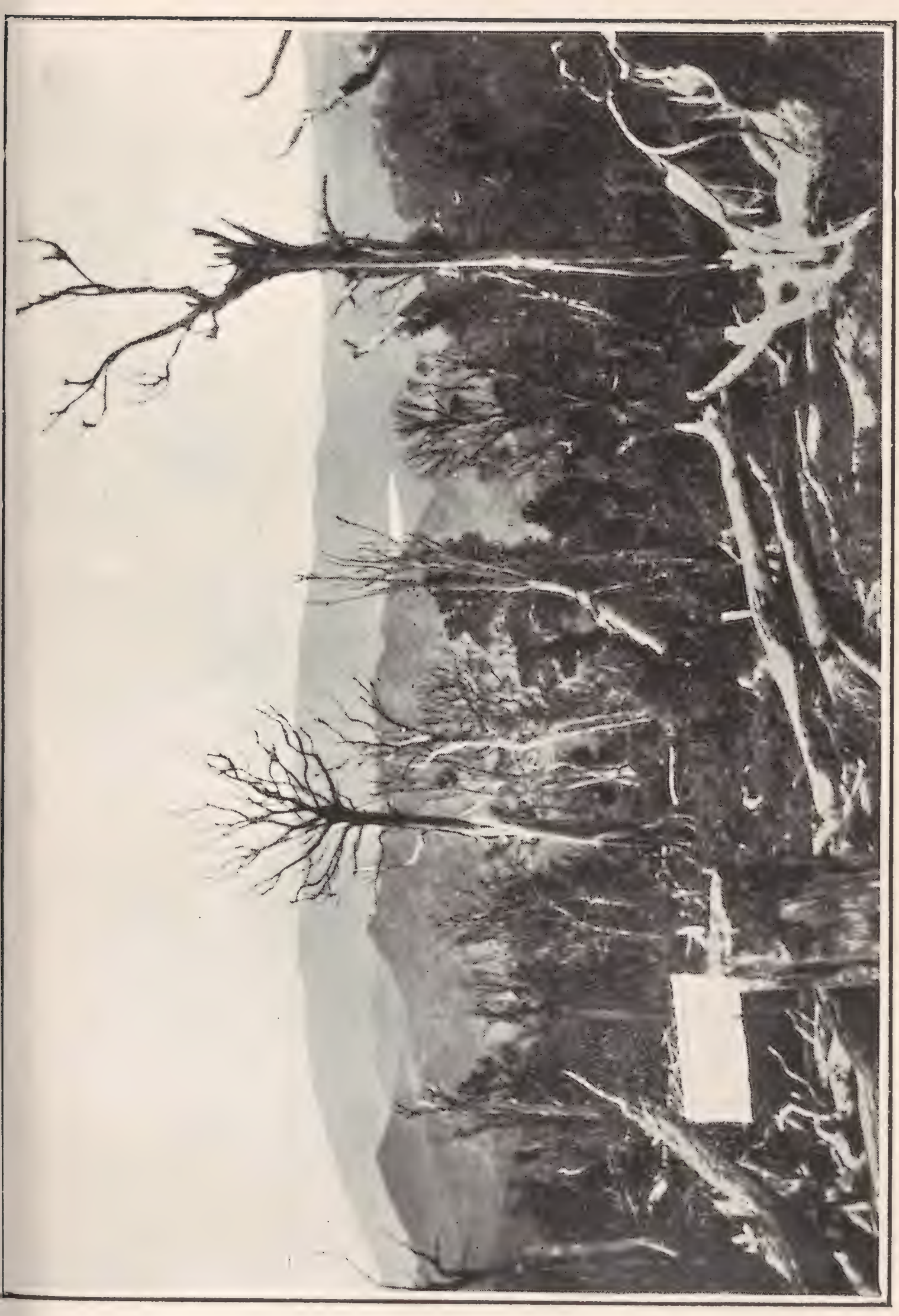
Fig. 1—*Liopelma hochstetteri*, embryo, 7 days.
Fig. 2—*Liopelma hochstetteri*, embryo, 14 days.

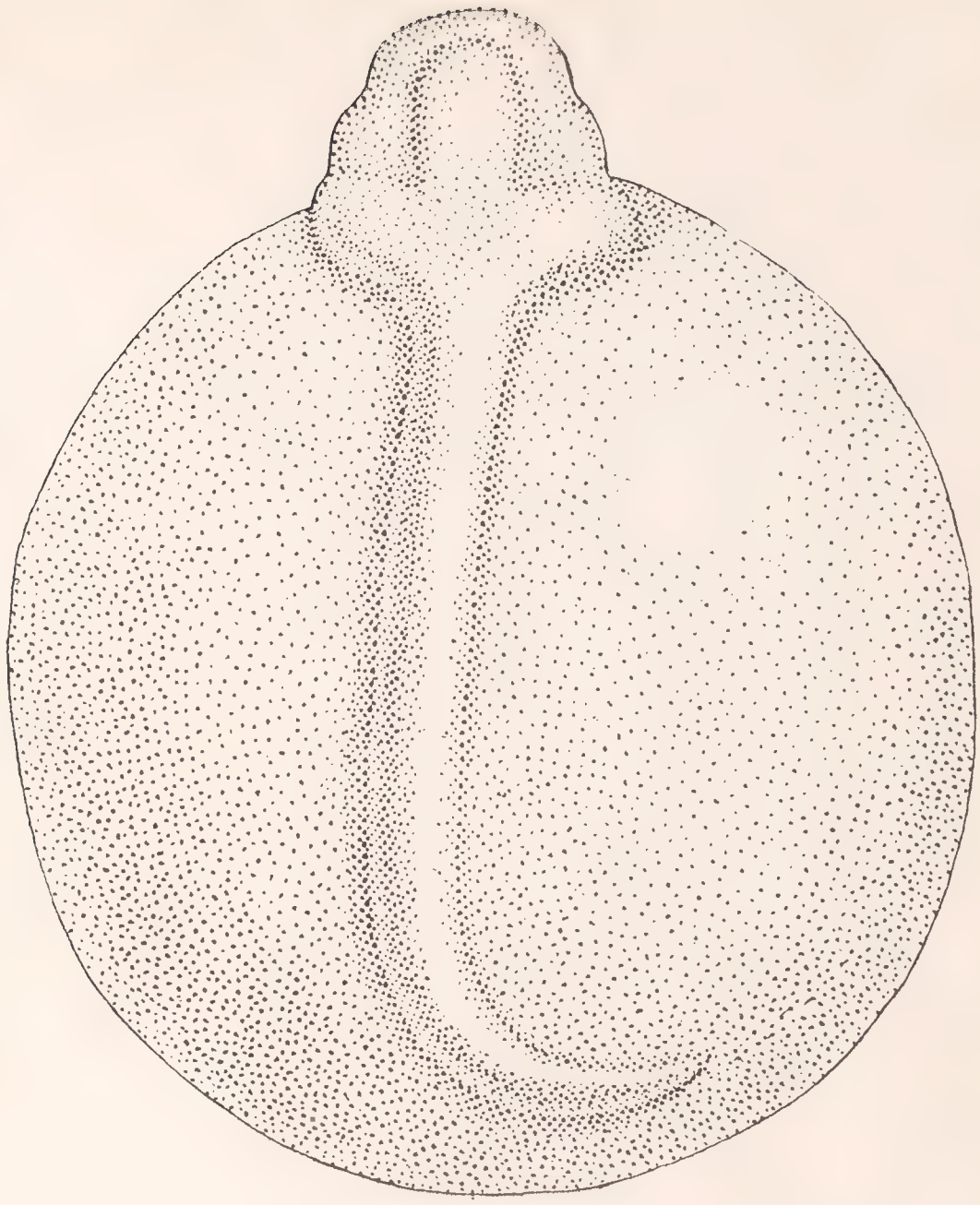
Plate XI.

Fig. 1—Larva, 20 days.
Fig. 2—Larva, 24 days.

Plate XII.

Fig. 1—Larva, 27 days.
Fig. 2—Young frog at hatching, 35 days.
Fig. 3—Young frog, one month after hatching.





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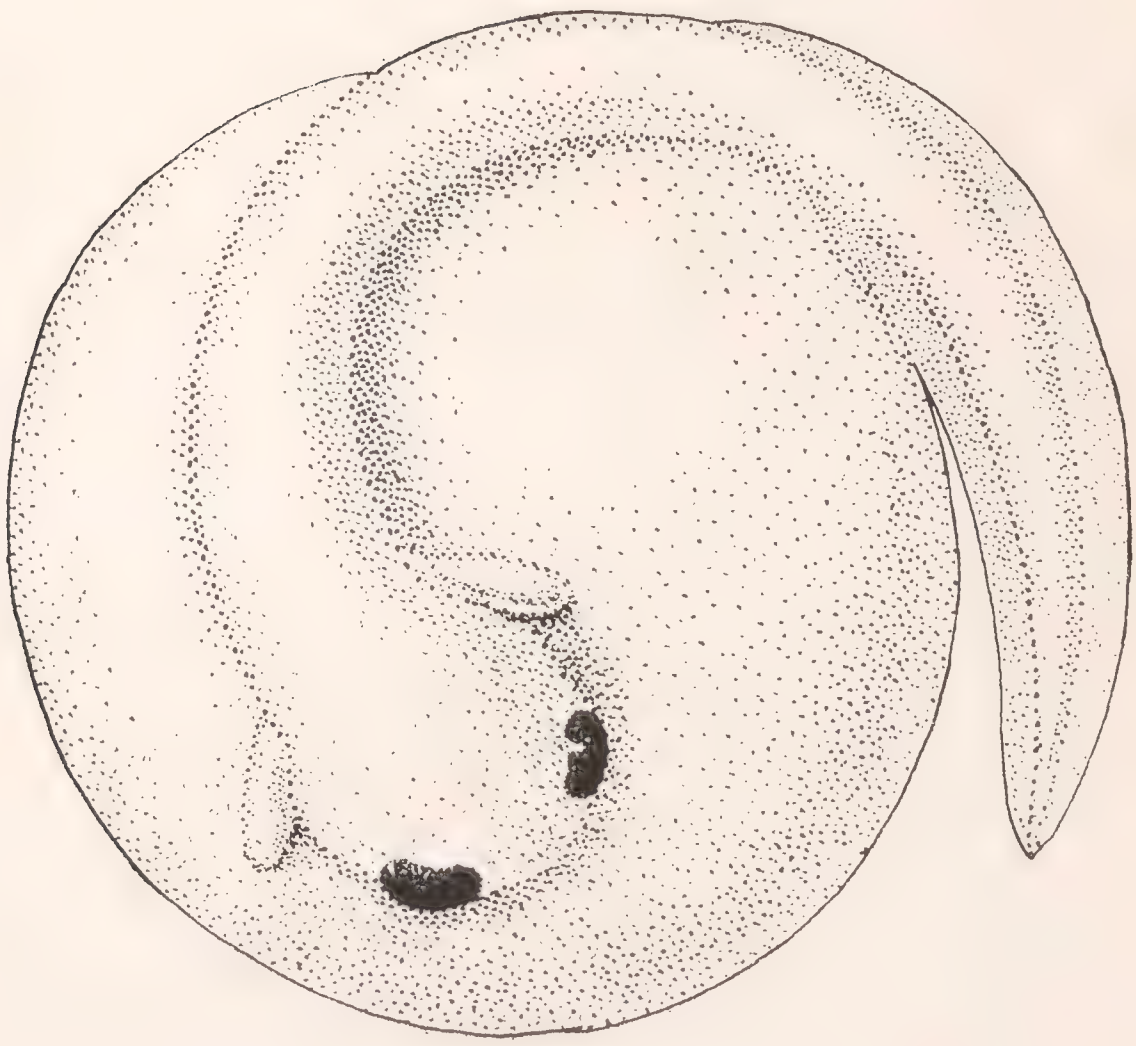

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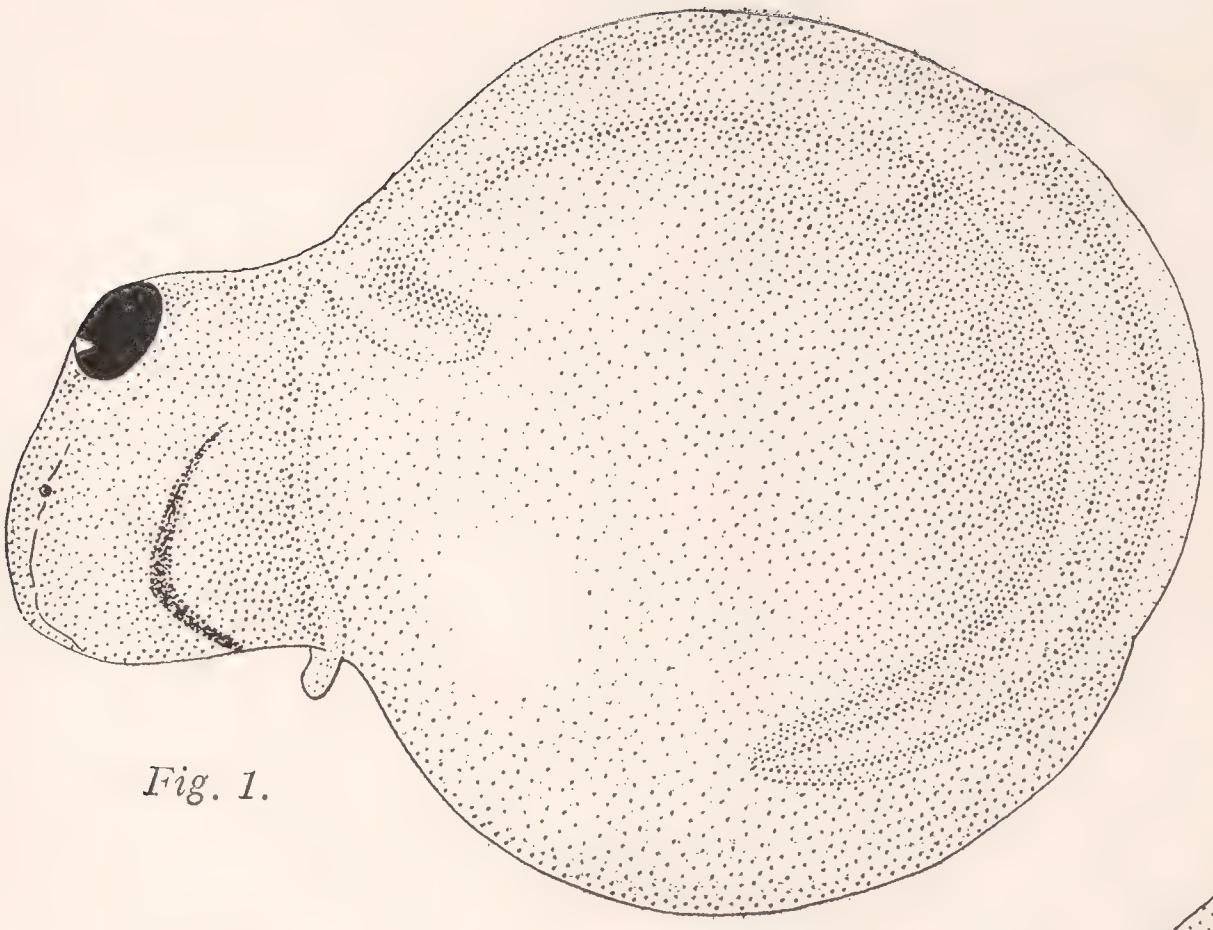

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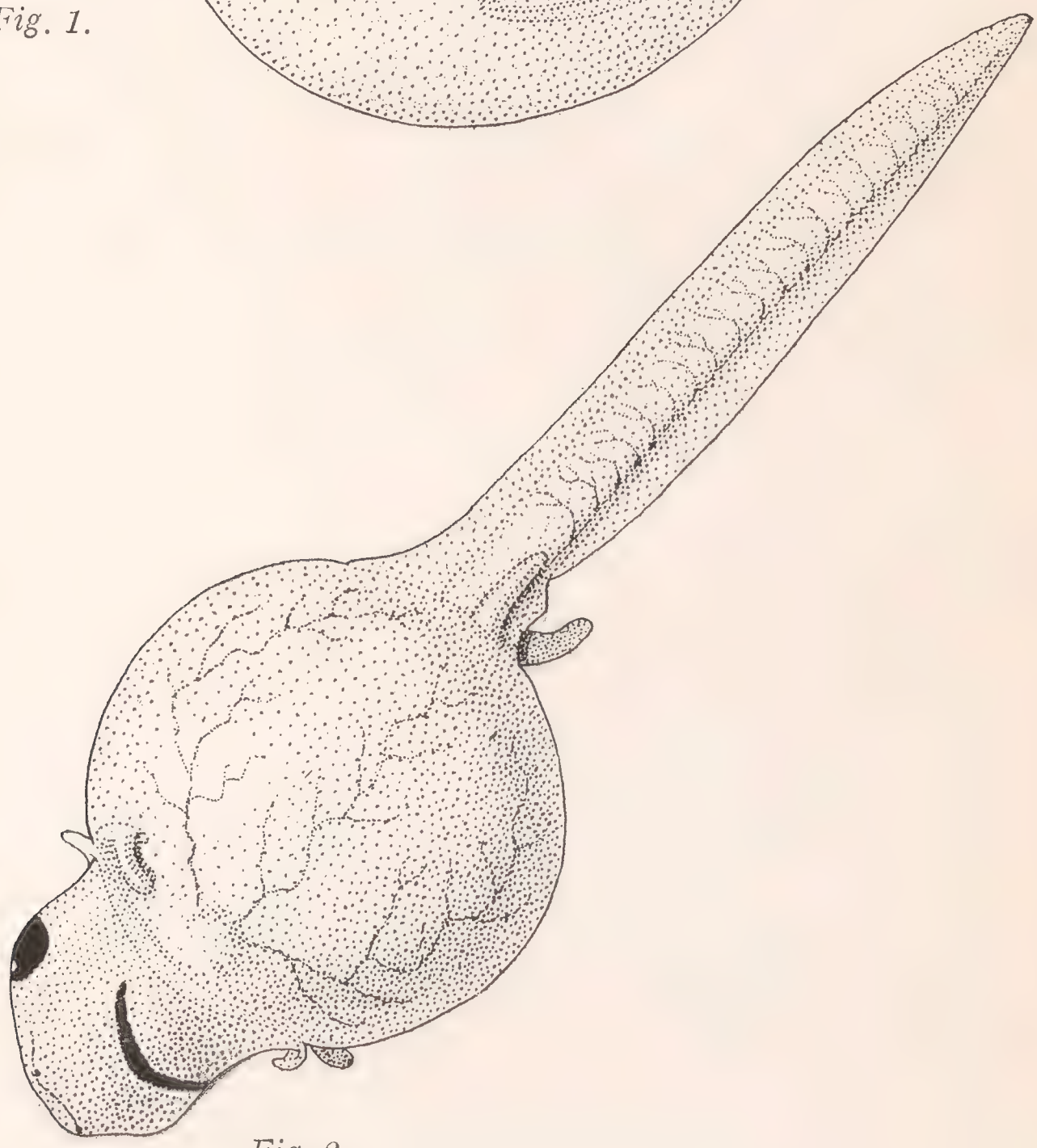

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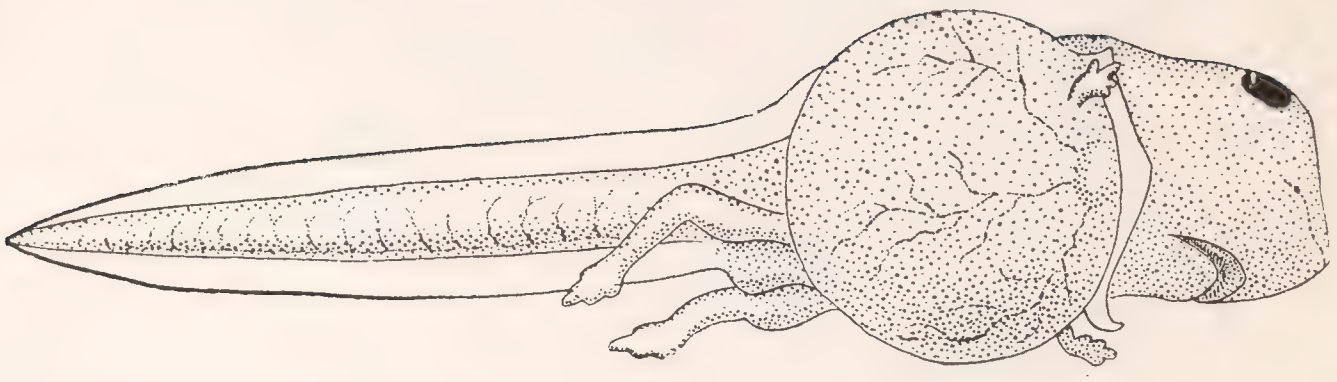


Fig. 1.

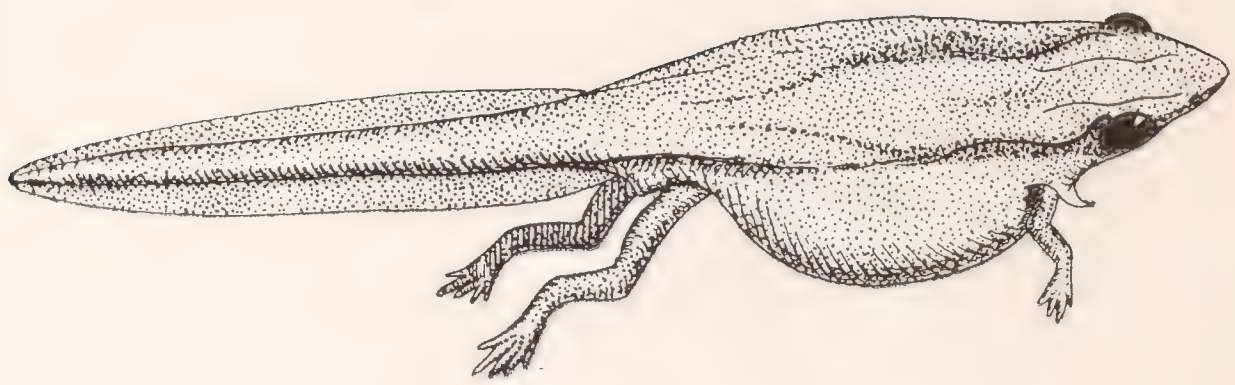


Fig. 2.

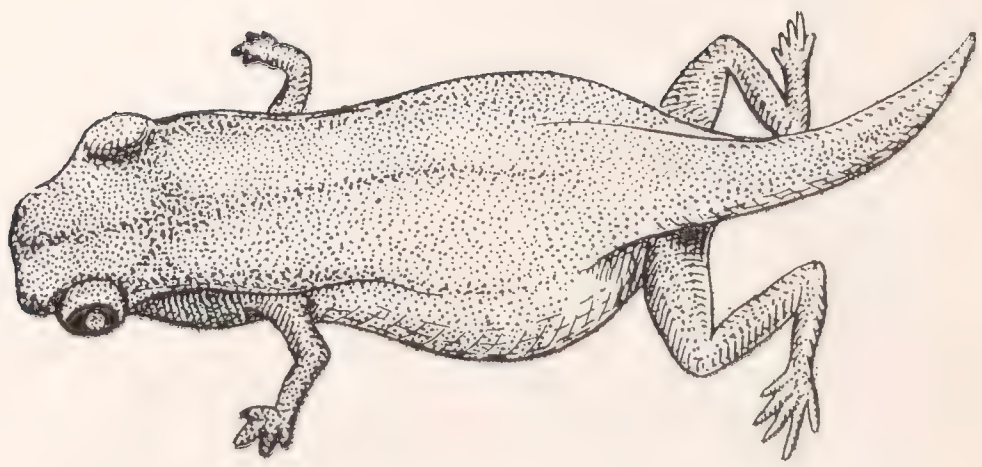


Fig. 3.

NOTES ON NEW ZEALAND CHILOPODA

By Gilbert Archey, M.A., Assistant Curator.

Plate XIII.

Geophilomorpha.

Geophilidæ.

Zelanophilus kapiti n. sp. (Plate XIII. figs. 1-1b).

Colour dull yellow (much faded in spirit), head broad, only 1.18 times longer than broad, frontal suture distinct, sides convex, anterior and posterior margins straight, overlaps basal plate, the latter 3.5 times as wide as the exposed portion. Prehensors, with claw extending nearly to front of head, unarmed, femuroid with tubercle inwardly, prosternum wide, unarmed.

Labrum with stout fringed laterals, encroaching on small tridentate median piece. No clypeal area. First maxillæ (fig. 1b), with fused coxæ, rami discrete, outer biarticulate, with distal joint much the longer, no lappets. Second maxillæ (fig. 1b), with coxæ fused, pore not enclosed, claw of palp undivided, but set with strong setæ.

Tergites bisulcate, but with no median sulcus, last tergite slightly longer than wide, rounded posteriorly. Last sternite longer than wide, narrowing posteriorly, caudal margin straight. Sternal pores present as a cross band on the first 27 segments. Coxopleuræ with 18 pores above, and 19 below, pores of various sizes. Anal legs with six joints besides coxa, and a small claw.

Leg-bearing segments 69, length 38 mm.

Differs from *Z. wheeleri* Chambr. in having three labial teeth instead of nine, in the absence of a median sulcus on the tergites, and in the separation of the rami of the first maxillæ.

Locality—Kapiti Island.

Chilenophilidæ.

Schizoribautia brittini n. sp. (Plate XIII., figs. 2-2a).

Colour yellow, darker anteriorly, head chestnut. Head 1.7 times as long as wide, frontal sulcus very faint, only visible at margins. Antennæ three times as long as the head, joints twice as long as broad, last joint not quite as long as the two preceding ones

together. First eight joints with a few long hairs, ninth with short and long hairs, remainder pubescent. Labrum (fig. 2a) with median piece one-third as long as laterals, armed with ten very small round teeth, laterals with a few hairs medianly. First maxillæ (fig. 2) with biarticulate outer ramus, no lappets. Second maxillæ with coxæ standing apart, pleural areas distinct, a process projecting from anterior mesal angle of coxæ ; first and second joints of palp with a small process on the outer distal angle, claw simple, long, straight. Clypeal area present, armed with four spines.

Basal plate trapeziform, as wide posteriorly as the following tergite, anterior three-fifths hidden by the head, and slightly overlapped behind by the first tergite. Coxæ of prehensors large, subquadrate, coarsely punctured, with two teeth anteriorly separated by a notch which leads to a broad furrow with thickened edges extending two-thirds the length of the coxæ. Femuroid with two rounded tubercles (one trochantal), claw joint with large dark blunt tooth basally, claws dark curved. Sternites with median sulcus, ventral pores present in a circular area on segments 2 to 17 ; from the 18th the area is divided by a median band of polygonal plates into two areas, which fade out by the 28th segment. Anal sternite as broad as long, narrowed posteriorly, angle rounded, posterior third with short, close-set hairs. Coxopleural pores four below, opening under sternite. Tergites bisulcate, anal tergite long, narrowed caudad, hiding most of coxopleuræ from above, pretergal plate large.

This species differs from *S. rainbowi* Bröl. in the presence of teeth on the median piece of the labrum, the presence of a small process on the first, as well as on the second joint of the palp of the second maxillæ, and by the armature of the prehensors.

Locality—Waipara, Canterbury (G. Brittin).

Scolopendromorpha.

Cryptopidæ.

Cryptops tokatea n. sp. (Plate XIII., fig. 3).

Colour : head, first and last tergites chestnut, remainder dark brown. Head covered posteriorly by first tergite. Longitudinal median sulci faint on 7th, complete from 8th to 20th segments, last tergite broadly triangular caudad, the apex rounded. Prosternum with straight chitinised edges, a few sub-marginal hairs. Sternites with well-marked recurved transverse sulcus from 2nd to 19th segments, longitudinal sulcus less clear. Last sternite with convex slightly converging sides, partly covering the coxopleuræ, angles rounded. Coxopleuræ rounded posteriorly, bearing about 80 fairly large regularly arranged pores, two rows of which are covered by the sternite, a fairly wide pore-free margin with scattered setæ.

Femur of penultimate leg pubescent below. Anal leg (fig. 3), with first joint strongly setose, especially below, second with less strong setæ, and with two spines below, tibia with 8 teeth, first tarsal with 4 teeth set upon a strongly developed sharp keel.

This species differs from *C. ignivia* Archey by the greater sharpness and prominence of the first tarsal keel, and the number of coxopleural pores. Length, 23 mm.

Locality—Tokatea Ridge, Coromandel (G.A.).

Cryptops arapuni n. sp.

Colour: head, 1st tergite and 17th to 21st tergites ferruginous, remainder dull brown, a dark median band along the back. Antennæ with 17 articles. Head overlapped by the 1st tergite, faintly punctured with fine hairs. First tergite with a Y-shaped depression. Median longitudinal sulci absent, lateral sulci present from 3rd to 18th segments. Prosternum with slightly convex anterior margin, a few fine setæ submarginally. Sternites with cruciform sulci to the 19th segment, last sternite as wide as long, with straight sides converging caudad, caudal margin convex. Spiracles very narrow oval, almost slit-like. Coxopleuræ not produced caudally, pores numerous, small, reaching nearly to caudal margin, except within, where there is a pore-free area set with setæ. Legs covered with moderately fine setæ, Anal legs missing.

This species resembles *C. modiglianii* Silvestri, and *C. monilis* Gervais, in having no median longitudinal sulci, it differs from the latter, which it more closely resembles, in possessing large slit-like spiracles, and in the form of the last ventral plate. Length, 42 mm.

Locality—Arapuni, Auckland (A. Lush).

Lithobiomorpha.

Henicopidæ.

Lamyctes chathamensis Archey (Trans. N.Z. Inst., vol. 49, p. 309).

This species previously known from the Chatham Islands, is now recorded from Taranaki (Mr. H. Bellringer).

Paralamyctes harrisi n. sp. (Plate XIII., fig. 4).

Colour (in spirit), chestnut brown. Head with well-marked frontal sulcus, and a median sulcus extending from anterior margin of head (which is medianly emarginate) to frontal sulcus. Eyes present. Antennæ with 17 to 20 segments, each about twice as long as broad. Prehensors (fig. 4) with long curved claw, provided with hairs for nearly half its length, remainder of prehensors hirsute, especially mesally; prosternum with broad dental margin, plentifully supplied with hairs; teeth, 2 + 2. Labrum, mandibles and

maxillæ of the usual form ; first maxillæ with plumose hairs on the outer ramus, and simple hairs on the inner ramus. Terminal claw of palp of second maxillæ tripartite. Tergites sparsely covered with short hairs, margined, first six with faintly emarginate posterior border, seventh to last tergite with posterior margin distinctly emarginate. Legs hirsute, first three joints yellowish brown, next two joints greenish, tarsal joints brown. Tibial spur present on first to fourteenth legs, tarsi all biarticulate with the first tarsal segment about twice as long as the second. Terminal claw of each leg with two slightly curved basal spines outwardly, and a small blunt spine inwardly. First tarsal joint of last leg twelve times as long as wide. Coxal pores in a wide furrow, the size of the proximal ones moderate, increasing considerably distad. 4 + 4. Gonopods of male 3-jointed, terminating in a long hair-like spine. Gonopods of female unknown. Length, 20 mm.

Locality—Tokatea Ridge, Coromandel (G.A.) ; Taumarunui (T. R. Harris).

EXPLANATION OF PLATE XIII.

Fig. 1 —*Zelanophilus kapiti,* Prehensor.
Fig. 1a—*Zelanophilus kapiti,* Labrum.
Fig. 1b—*Zelanophilus kapiti,* first and second maxillæ.
Fig. 2 —*Schizoribautia brittini,* first and second maxillæ.
Fig. 2a—*Schizoribautia brittini,* Labrum.
Fig. 3 —*Cryptops tokatea,* Anal leg.
Fig. 4 —*Paralamyctes harrisi,* Prehensors.

Fig. 1.

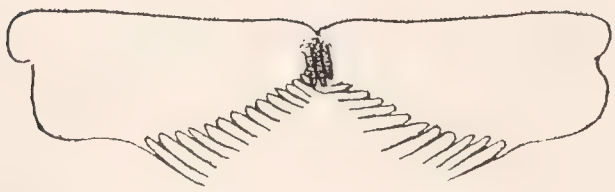


Fig. 1a.

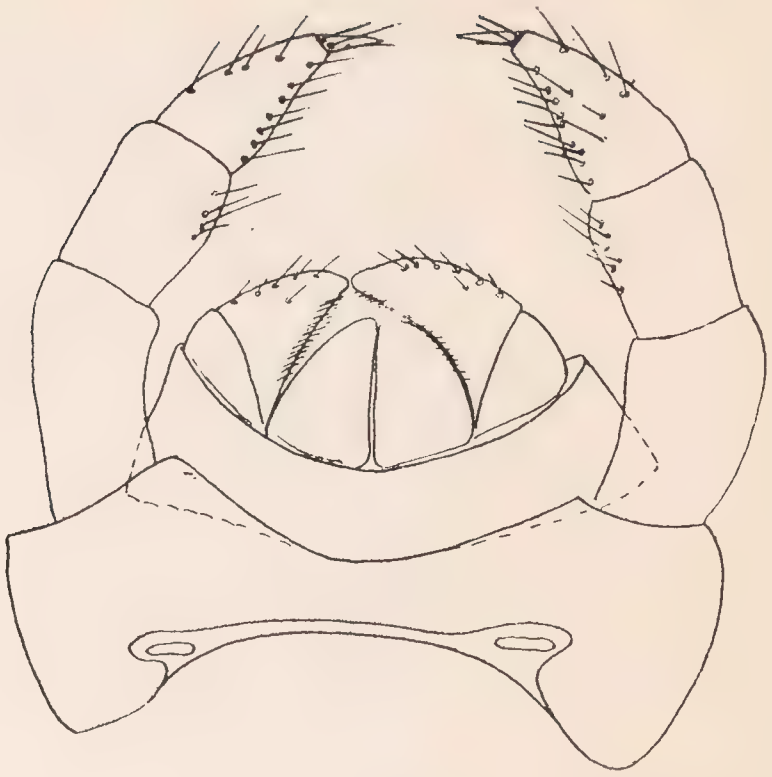


Fig. 1b.

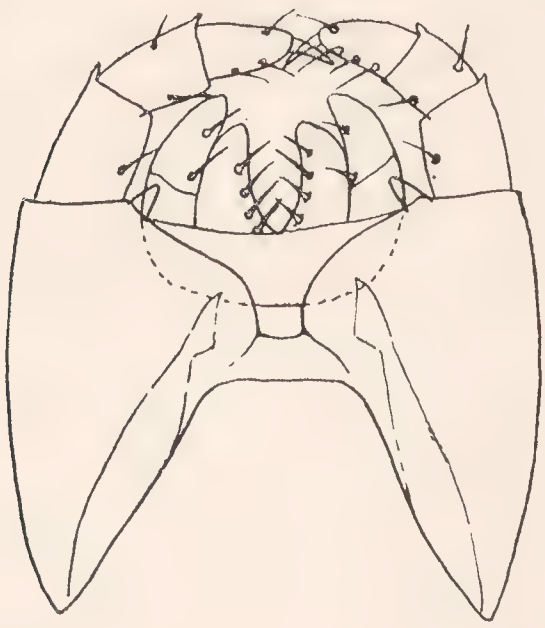


Fig. 2.

Fig. 2a.

Fig. 3.

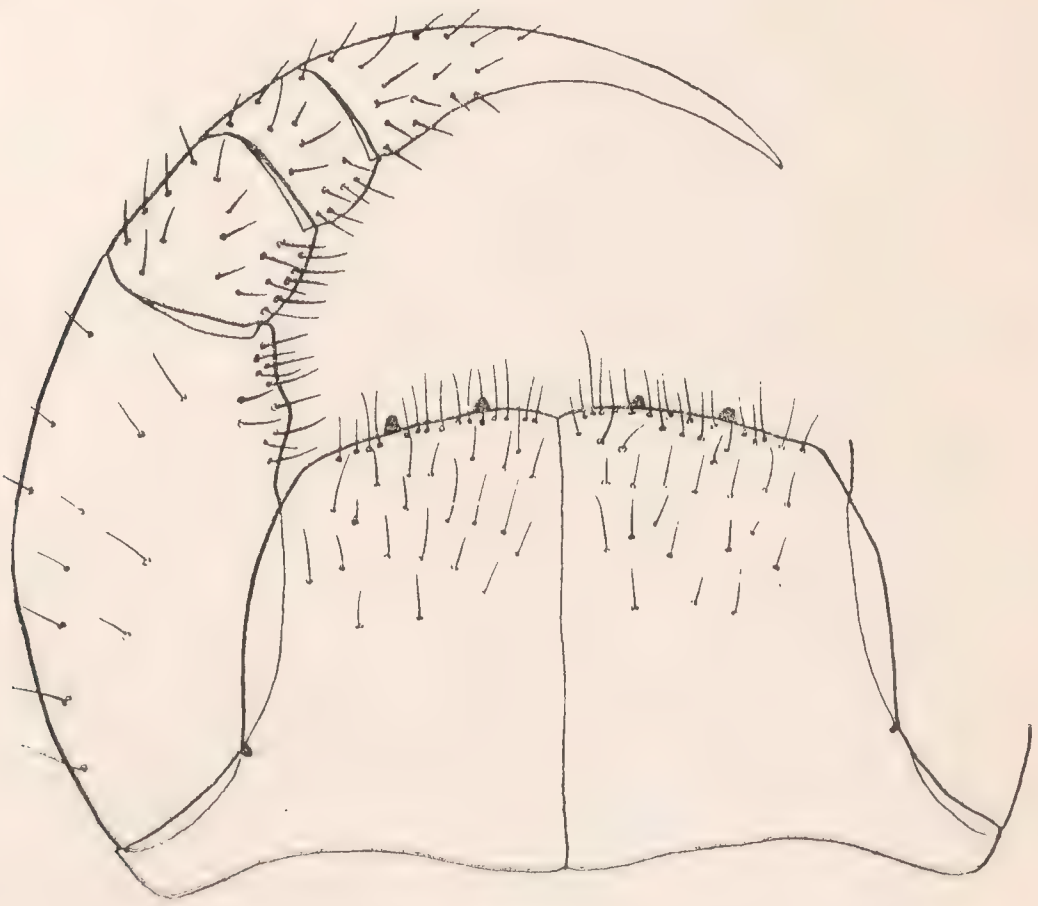


Fig. 4.

THE RHYOLITES OF BANKS PENINSULA

By R. Speight, M.A., F.G.S., F.N.Z. Inst.

Plates XIV.–XVI.

The petrography and petrology of the Rhyolites of Banks Peninsula have not up to the present received much attention in geological literature. Their stratigraphy has been dealt with by Haast in various papers and reports, and his mature opinions are no doubt expressed in his "Geology of Canterbury and Westland" (Christchurch, 1879). The present writer has also considered the question in a recent paper on "The Geology of Banks Peninsula" (Trans. N.Z. Inst., vol. 49, 1917, pp. 365-392), to which the reader is referred for information as to the precise position of the localities mentioned subsequently in this article. The most satisfactory account of the petrology of these rocks is that furnished by B. Kolenko, entitled "Mikroscopische Untersuchung einiger Eruptivgesteine von Banks Halbinsel, Neuseeland" (Neues Jahrbuch für Mineralogie, Geologie und Palæontologie I., 1-20, 1885), a translation of which into English appeared in the N.Z. Journal of Science, vol. II., 1885. Some reference is made by H. Filhol in the "Mission de l'Ile Campbell (Paris, 1885), but the opinions given there are obviously inspired by von Haast, and do not add any new facts of importance, except a brief and somewhat indefinite account of the microscopical nature of the rock. Hutton has also briefly described a few specimens in his paper on the "Igneous Rocks of New Zealand" (Journ. and Proc. Roy. Soc., N.S.W., 1889), but for information concerning their field relations he relied almost entirely on von Haast. Thus the only petrological accounts

available were based on the examination of isolated specimens, and were made by persons not well acquainted with the occurrence of the rocks in the field. This paper, therefore, embodies an attempt to correlate the various lines of evidence in connection with the character of the rocks, as a result of both field and microscopic observations of my own, the value of which has been materially increased by analysis of typical rocks carried out most generously in the Dominion Laboratory by the consent of the Dominion Analyst through the kind office of the Director of the Geological Survey. For this most valuable help my cordial thanks are due.

Field Occurrence.

The Rhyolites and related volcanics of the Banks Peninsula system are of Cretaceous age, and are best developed in the neighbourhood of Gebbie's Pass ridge, and on the spurs stretching down from it towards Gebbie's Valley on the one hand, and towards the head of Lyttelton Harbour and Quail Island on the other. Their relations to the underlying sedimentaries has been described in my former paper (loc. cit., pp. 373-6). The rhyolites consist of flows and agglomerates, the latter consisting almost entirely of rhyolitic material, though they include fragments of the underlying greywackes and of andesites of a type not actually located within the area, and in all probability buried up under the other volcanics in their immediate neighbourhood, and not exposed to sight by denudation. Penetrating the rhyolites are trachytic and basaltic dykes belonging to a later epoch, but pitchstone and rhyolite dykes occur in places, notably in the vicinity of the crest of the ridge, and of age no doubt approximately contemporaneous with that of the rhyolites they intrude—judging by their similarity in chemical and petrological composition. Fragments of rhyolite occur in an agglomerate bed exposed at the base of Onawe Peninsula, Akaroa, and the whole occurrence of the rocks is no doubt connected genetically with the rhyolites, which extend along the eastern base of the Southern Alps from near the Selwyn River through Rockwood to Rakaia Gorge, are again developed on a large scale at Mount Somers, and reappear in the Rangitata Valley between Forest Creek and Coal Creek on the north-eastern extremity of the Ben Macleod Range.

In order to furnish an accurate conspectus of the petrological character of the rhyolites as a whole, selected examples will be taken, treated fully, and variations will be noted as occasion demands.

ERRATUM.

"Records" of the Canterbury Museum, Vol. II., No. 2, p. 79, 4th and 5th lines from bottom, should read—

1, 3, 1, 3, Alaskose.

Chemical Composition.

The results of the analysis of three rocks made in the Dominion laboratory are as follows :—

		1	2	3
Silica	SiO_2	76.57	75.37	74.96
Alumina ..	Al_2O_3	13.04	12.21	11.76
Ferric Oxide ..	Fe_2O_3	0.20	0.86	0.79
Ferrous Oxide ..	FeO	0.51	0.42	0.45
Magnesia ..	MgO	0.13	0.23	0.11
Lime	CaO	0.05	0.25	0.36
Soda	Na_2O	3.42	2.91	3.06
Potash	K_2O	4.66	4.99	5.08
Combined Water (above 105° C) ..	H_2O+	0.54	0.55	3.29
Water (below 105° C)	H_2O-	0.60	1.48	0.31
Carbon dioxide ..	CO_2	none	none	none
Titanium dioxide	TiO_2	0.06	0.11	0.12
Zirconia	ZrO_2	0.02		
Phosphorus pentoxide ..	P_2O_5	0.15	0.26	0.16
Sulphur ..	S	trace		
Manganous Oxide	MnO	0.02	0.01	0.02
Nickel Oxide ..	NiO	none	none	none
Strontia	SrO	none	none	none
		99.98	99·65	100.47

No. 1—Rhyolite, from road, Manson's Peninsula, Lyttelton Harbour.

No. 2—Microspherulitic Rhyolite, from quarry at top of Gebbie's Pass, Lyttelton Harbour.

No. 3—Perlitic Pitchstone, from ridge north-west of Gebbie's Pass, Lyttelton Harbour.

These would be classified as follows, according to the Washington-Iddings system :—

No. 1—1, 3, 1, 3	Alaskose.
No. 2—1, 3, 1, 2 (3)	Magdeburgose (Alaskose).
No. 3—1, 3, 3 (2)	Alaskose (Magdeburgose)

The analyses suggest nothing remarkable, except that the rocks are practically composed of quartz and felspar, a point which is confirmed by the microscopical examination.

Petrography.

A very widely distributed type of rock is that developed on Manson's Peninsula, the spur dividing Governor's Bay from the Head of the Bay. Good exposures are obtained along the shore, and also in the cuttings of the road over the spur. Microscopically this is a whitish rock, with phenocrysts of dark smoky quartz and sanidine felspar freely developed. The former are small, up to 0.5cm. in length, but the latter sometimes attain a length of 3cm. and even more.

Under the microscope the slide shows the presence of phenocrysts of quartz with rounded outlines, clear, and with occasional inclusions. The felspars are chiefly sanidine, the amount of plagioclase being relatively unimportant, both show incipient sericitisation along cracks, and minute inclusions of brilliantly polarising zircon. The biotite is much corroded and replaced by iron ores. The ground mass is largely a holocrystalline mixture of quartz and felspar, in places it is crypto-crystalline, and the two phases pass into each other; patches of indefinite micrographic texture also occur. This is such a frequent feature of specimens from other localities of the area that its presence should be noted. Very small flakes of mica, with feeble but distinct pleochroism are also present, and also, in some places, a considerable quantity of brilliantly polarising sericitic material. The general texture of this rock approaches that of a typical quartz porphyry, and it resembles closely the texture of some of the rhyolites of Malvern and Mount Somers. Analysis No. 1 (p. 79) shows its chemical composition.

Although garnets are such a characteristic feature of the rhyolites of these two localities, they are rare in the exposures in the vicinity of Gebbie's Pass. I have only found them in fragments of the agglomerate near the summit of the pass, and on the south side of Quail Island. They are of the reddish-brown variety. The characters of the fragments containing this mineral are somewhat similar to those of the typical rhyolite of Manson's Peninsula.

Owing to the infrequency of the occurrence of garnet in this area no further reference need be made to the circumstances of its occurrence in igneous rocks, such as inferences as to the deep-seated origin of the rock containing it. It was, however, not observed in the lithophysæ, to be referred to later, although garnets have been reported as occurring in lithophysæ in rhyolite from Colorado, by Whitman Cross (Amer. Journ. of Science, vol. 31, 1886, p. 432), and the possibility of the mineral occurrence under similar circumstances should be considered here.

A most interesting variety of the rhyolite is that which occurs along the foreshore on the south side of Quail Island. At two points

the development is typical, (1) along the rocky edge of the water between tide marks about five chains west of the outer wharf, and (2) on the road leading from the inner wharf to the immigration buildings. At the former the rock is characterised by the presence of numerous lithophysæ up to 10 cm. in diameter, with an average of about 5-7 cm. At times these constitute the greater part of the rock (see plates XIV. and XV.). The lithophysæ are frequently hollow, but occasionally, as a result of silicification, they are solid. Sometimes they are indefinite in outline, and grade into the surrounding matrix which is stony in appearance and white in colour ; they are, however, frequently stained on the outside by a coating of iron oxide. They are, as a rule, easily separable from the matrix, but at times are firmly attached to it ; concentric structure is common. The surrounding rock shows well marked flow structure, the layers being tortuous and irregular. In places where the spherulites make up the bulk of the rock the flow lines are quite indefinite, but where they are scattered the lines appear to curve round them. This is specially the case where they have departed from the spheroidal shape, and taken on a lens-like form, an occurrence which is, after all, somewhat rare.

In the other locality, viz., that on the road west of the inner wharf, the spherulites are not so large, and do not exceed 1 cm. in diameter ; they make up, however, nearly 90 per cent. of the rock ; otherwise the macroscopic appearance of the rock is similar. It is undoubtedly a flow, and it is possible that the two separate occurrences may be part of the same mass.

When examined under the microscope the rock appears to be well silicified. Separate areas in the slide are formed of a mosaic of quartz grains, but these shade off into cryptocrystalline and microfelsitic material. Sometimes patches of the ground mass show ill-defined cloudy masses with micrographic structure in various stages of distinctness. Phenocrysts are almost entirely absent, and when the quartz grains take on the larger sizes, the boundaries of these aggregations are quite indefinite, and grade down into the ground mass. Small ragged flakes of brown pleochroic mica and grains of iron oxides occur freely in some slides, and there are patches of sericitic material derived from the felspar content of the rock. In parts where flow lines are apparent there is a division of the rock into subparallel layers of material, which show, on the one hand, little evidence of crystallisation, the rock being practically a glass with a few microlites of felspar arranged on flow lines.

The two following analyses, kindly made for me by Mr. R. O. Page, M.Sc. of the Woolston Tanneries Company, give some idea of the average composition of the spherulite bearing rock, and of the

spherulites themselves, analysis No. 1 being of the rock, and No. 2 of a selected spherulite :—

		1	2
Silica	SiO_2	75.20	82.04
Alumina	Al_2O_3	15.25	10.61
Ferric Oxide	Fe_2O_3	0.38	1.26
Ferrous Oxide	FeO	0.36	0.36
Magnesia	MgO	0.53	2.04
Lime	CaO	0.76	1.44
Soda	Na_2O	1.84	0.39
Potash	K_2O	4.64	1.09
Water combined above 105°	H_2O+	1.05	0.70
Water below 105° ..	H_2O-	0.54	0.46
Carbon Dioxide	CO_2	—	—
Titanium Dioxide ..	TiO_2	0.10	0.05
Manganous Oxide ..	MnO	—	—
		100.65	100.55

The first of these analyses does not differ materially from those given previously, except that there is a slightly higher percentage of alumina and magnesia and a lower percentage of soda. That of the spherulite shows traces of the effect of some agent, which has increased substantially the quantity of silica and magnesia, has increased slightly the amount of lime, and reduced materially the alkalies and the alumina. This has, in all probability, been effected by hot water, probably charged slightly with magnesian salts, the source of which it is tempting to assign to the basaltic lavas which subsequently to the rhyolitic eruptions inundated the locality.

The spherulites are a most noteworthy feature. Usually they are hollow, and of roundish outline, but frequently the interior cavity is completely filled with a quartz mosaic. When not completely filled the inner margin is bounded by a similar mosaic, coarser near the interior margin, but getting finer towards the outskirts of the spherulite and passing at times into true spherulitic rays arranged radially, and composed of both quartz and felspar. On the whole, however, the radial arrangement is obscure, and it is frequently absent. There is thus little resemblance to the hollow spherulites described by Iddings as occurring at Obsidian Cliff, Yellowstone National Park (Seventh Annual Report U.S. Geol. Survey, 1888, and also Igneous Rocks, vol. 1, pp. 234-240), and by Cross as occurring at Rosita Hills, Colorado (Seventeenth Annual Report, U.S. Geol. Survey, 1896, Pt. 2, pp. 296-303). They resemble rather the aggregates in chert described by Sargent (Carboniferous Cherts of Derbyshire, Geol. Mag., vol. 58, 1921, p. 269). Their structure shows as well marked differences from that

described by Rutley (Notes on the Rhyolites of the Hauraki Gold Fields, Q.J.G.S., vol. 55, 1899, p. 449, and Additional Notes on some Eruptive Rocks of New Zealand, Q.J.G.S., vol. 56, 1900, p. 493), and Sollas (The Rocks of Cape Colville Peninsula, Wellington, 1905). The echinate spherulites described by the former of these writers, and the cervicorn and related forms described by the latter do not occur in the Quail Island or in any of the Gebbie's Pass rhyolites.

The borders of the hollow spaces were carefully examined by Becke's method in order to determine if any mineral of lower index of refraction than balsam were present, but with little success, the only substance of low index detected being clearly chalcedony arranged with agate-like bands forming a boundary to the cavity in certain sectors. In one specimen calcite occurred fringing the edge of the cavity, and forming crystalline aggregates in the interior. In view of the percentage of magnesia shown in the analysis of the spherulite, the possibility of the occurrence of magnesian-bearing minerals was fully considered, but none were detected. Cordierite was specially looked for, since it has been reported as having been formed in adjacent rocks by basaltic intrusions, and its presence might well be overlooked in conjunction with quartz.

In sections where flow lines appear, they generally arrange themselves round the boundaries of the spherulites, indicating that these were formed while the rock was in a fluid or plastic condition. The silicification no doubt resulted from agencies operating after these structures were definitely established in the rocks.

A very interesting variety of these acidic rocks occurs on the top of the Gebbie's Pass ridge just west of the point where the road crosses it. A small quarry has been opened in it for road metal. The rock in the quarry is much jointed into more or less irregular shaped angular masses, the largest of which are about 15 c.m in length. The colour is whitish, and the rock is apparently slightly kaolinised (see analysis No. 2), but harder than might be expected from a casual inspection. It is composed of sub-parallel, wavy, and tortuous layers, with numerous small cavities, perhaps the remains of lithophysæ, round which these wavy layers appear to pass. (See plate XVI.). The outlines of small spherulites are at times freely visible, but there is considerable range in the microscopic texture. Phenocrysts are not visible macroscopically.

Under the microscope the rock appears to be composed of bands of more or less distinctly crystalline matter alternating with those in which the crystalline character is not so apparent. The crystalline material is chiefly quartz, with a considerable quantity of a clear colourless mineral of lower refractive index forming a mosaic with the quartz. This I cannot identify with certainty, but it has not the structure commonly associated with tridymite, so it is not

likely to be that mineral. Numerous small flakes of biotite also occur. The ground mass varies considerably in texture; in places it is distinctly microspherulitic, and there are also indefinite mossy patches showing graphic intergrowth. Some areas hardly let any light through, and must be considered microfelsitic in structure. They are brownish in colour, and of lower index of refraction than balsam. Bands of these alternate with those distinctly crystalline and whitish in colour, and then again, some of the bands are glassy, and show the presence of trichites in eyelash form; very occasional small phenocrysts of quartz and felspar also occur.

The slides from one sample of this rock show beautiful spherulites up to 4 mm. in diameter, exhibiting between crossed nicols a dark cross, in some cases with the arms parallel to the cross wires, and in others definitely inclined at a small angle, indicating that a felspar plays an important part in the formation of the spherulites. The low angle of extinction points to oligoclase, but the low percentage of lime given in the analysis shows that the felspar must be closer to the acidic end of the felspar series. When examined under higher powers the rays take the form of felspar fibres, but between them, with radial arrangement, are quartz fibres with higher polarisation colours, and higher index of refraction, as shown by Becke's test.

The fibres frequently exhibit a negative elongation, which points to their being felspar, the other fibrous minerals with negative elongation being excluded for other reasons. When the field is examined with a gypsum plate, the regularity of the similarly coloured sectors throughout the field is most striking, showing that the majority have similar orientation, but it must be noted that a small percentage show a reversal of colours, and in default of a satisfactory explanation for their variation must be considered to possess a contrary elongation.

The radial growth occurs successively in concentric shells. In some cases the fibres are arranged at right angles to an axis—axiolitic, usually forming a double row, with ends directed towards the axis, not meeting in the middle, but separated either by a quartz mosaic or by a strip of glass, which exerts some effect on polarised light. This is reminiscent of the forms described by Pirsson in a paper entitled "On an Artificial Lava-Flow and its Spherulitic Crystallisation" (American Journ. Sci., vol. XXX, 1910, pp. 102-3). The wavy bands of the rock under consideration are also alike in some respects to the wavy bands shown in the glass described in this paper (see fig. A., plate 1), and attributed by the author to flow structure, although on pp. 425-6 of the same volume he quotes a letter from a Mr. Frind, in which another suggestion is made, viz., that the bands of spherulites are due to a layer of air lying between layers of glass which are not quite in contact, and

that the presence of this layer has promoted crystallisation. This explanation does not seem at all foreign to the occurrence in the rock under consideration. The presence of bands of crystalline quartz mosaic suggests that there were opportunities for crystallisation along these bands, and that the opportunity may have been afforded by air spaces formed when the rock was in a viscous condition, and layers overlapped without actual contact as the final movements took place.

The typical spherulitic structure grades into indefinite granophyric structure with sponge-like intergrowths, and then again the structure becomes felsitic rather than microfelsitic.

Analysis No. 2 (p. 79) is of a sample of stone from this quarry. It shows a remarkable similarity to the results given by No. 1, the stone from the road crossing the spur of Manson's Peninsula. The fact that large areas of the slide of both rocks show what is practically a graphic intergrowth—and therefore, in all probability, the result of crystallisation from a eutectic mixture—points to the conclusion that the quartz mosaic of the rock on the summit of the pass is the equivalent of the quartz phenocrysts of the rock from Manson's Peninsula, and therefore they were formed originally from the magma, and are not the result of subsequent silicification. Even if the latter is the case the silica needed for the formation of the quartz must have been derived from the magma itself, and not been introduced subsequently. The rock is certainly a devitrified glass, but this devitrification has been produced during the process of consolidation, and is not of secondary origin.

The occurrence is, in all probability, a dyke penetrating agglomerate, though the contacts with the surrounding rocks are completely obscured at present, and its intrusive nature is not manifest ; this point will no doubt be settled by further quarrying. If this turns out to be the case, the dyke will probably be found to run parallel with the pitchstone and rhyolite dykes, which lie further to the north on the high ridge north-west of the pass.

Somewhat similar banded rhyolites occur freely as fragments in the agglomerate just mentioned, and their presence suggests that other masses of similar structure, from which these fragments were obtained were in existence prior to the intrusion just mentioned. These have not been located, and there seems little likelihood that they will be, unless quarry or road-making operations disclose them by chance. A somewhat interesting fragment from the agglomerate exhibiting banded structure is black in colour. Microscopically it appears to be composed of bands of small spherulites, .05 mm. in diameter, packed together like apples in a case, so that they are almost touching. Well marked flow lines pass through them, suggesting that the spherulites were formed subsequent to the solidification of the rock. The intervening spaces contain fewer

spherulites, which are arranged in a matrix composed of glass clear in colour, with microfelsitic material, and also crystalline matter in which quartz and felspar occur as indefinite micrographic intergrowths. The crystalline material sometimes forms growths round or partly round the spherulites, and it is then composed of quartz without the felspar.

An undoubted dyke of pitchstone occurs close to the top of the ridge north-west of the pass. Alongside this dyke are others of smaller size, so that the total thickness approximates about 70 feet. In the hand specimen the rock appears of bright resinous, almost vitreous lustre, black in colour, and with a flaky fracture. On the surface exposed to the weather there are numerous small spherical bodies, up to 5 mm. in diameter, detached from the rock. These, at first sight, might be taken for spherulites, but the microscopic examination shows none of these structures to be present, but well marked perlitic cracks occur, so that there is no doubt that these are rounded masses, which have separated along the perlitic cracks, analogous to the marekanite found in Mexico, and described by Rosenbusch ("Physiographie der Massigen Gesteine," pp. 830-1, 1908). The phenocrysts consist of much cracked sanidine and quartz, with very occasional plagioclase, the latter usually in aggregations. The sanidine contains minute rounded grains of a mineral of very high polarisation colours, high relief, yellowish tint, and therefore probably zircon. The chemical analysis confirms its presence. The plagioclase has slightly a higher refractive index than the balsam, and is therefore an oligoclase-andesine. The ground mass is entirely of glass, with well marked perlitic cracks and very numerous crystallites. These are mostly of trichites with the characteristic eyelash form, but globulites, margarites and longulites also occur freely. The last-named often show marked irregularities and serrations at the edges like broken combs, so that they have the features of skeletal crystals, but they have no effect whatsoever on polarised light, so they must be regarded as crystallites and not microlites. They are arranged in subparallel lines due to flow structure, and in certain parts the streams are crowded with these minute forms, while adjacent strips are relatively free from them, and form an almost pure glass. The splitting of the rock is parallel to these streams, and is independent of the perlitic cracks, although the globular masses do undoubtedly separate along them when the rock has been subject to weathering. Patches of brownish material, which have some slight effect on polarised light, occur sparingly. Analysis No. 3 (p. 79) shows the composition of this rock.

Occasional references are made in Haast's account of the district to the occurrence of rhyolite dykes on the crest of the ridge to the north-west of the pass. One of these exhibits well marked poly-

gonal jointing, the columns lying horizontally across the dyke. This rhyolite exhibits considerable variation in different parts of the exposure. At the south-east end of the ridge the rock appears under the microscope to be largely composed of a mixture of equidimensional grains of quartz and felspar ; spherulitic structure is occasional, the rays having negative elongation when the structure is definite, but, as a rule, the spherulites are indefinite in appearance, and grade into mossy intergrowths. Phenocrysts of quartz and sanidine occur most sparingly, and there are numerous flakes of mica scattered through the rock. These are not much larger than the elements of the ground mass. In some of the cavities are clear crystals, with distinct relief, low polarisation colours, and index of refraction lower than balsam. These might be tridymite, though there is no development of the scaly arrangement characteristic of that mineral. A finer-grained, more homogeneous variation of the rock occurs in association with this near the eastern end of the ridge.

On the summit of the ridge the rock is of coarser texture, the crystal elements are larger, and there is a great development of spherulitic structure. The spherulites range up to 0.3 mm. in diameter, and show clearly the radial arrangement of the fibres. These, in many cases, show inclined extinction and a negative elongation, though this is not invariably the case. Their behaviour under the gypsum plate is quite irregular at times, and areas where the coloured sectors are regularly oriented are associated with adjoining areas where the orientation is at haphazard.

Axiolites as well as irregular intergrowths are common. The rock under the microscope shows considerable resemblance to one coming from the S. to S.E. slopes of Mount Hobson in Great Barrier Island, kindly lent me for comparison by Mr. Bartrum, of Auckland University College.

At the west end of the ridge there is a reversal to the type of rhyolite seen in Manson's Peninsula, and described first. This is quite different from the usual features of the dyke, and the specimen may be derived from the country rock. This dyke is parallel to the pitchstone dyke referred to previously.

At the spot a few chains below the point where the road begins to ascend the pass on the southern side occurs an outcrop, which may be part of a great dyke running in an easterly direction, since there are numerous outstanding rocky masses, evidently dipping at a high angle in direct alignment with it ; it may, however, be part of a tilted flow, whose outcrop simulates that of a dyke ; no contacts with the neighbouring rocks have been exposed up to the present. Fantastic shapes produced by weathering are a notable feature of the landscape where the rock is exposed. Certain parts of it are strongly silicated, so that it is in places almost

flinty in texture. It is white or pinkish white in colour. Under the microscope it shows the presence of phenocrysts of quartz and felspar, the latter being both sanidine and plagioclase; these are generally broken. The ground mass is composed of cloudy and more or less defined patches of micrographic structure, many of these being grouped round the quartz phenocrysts, and attached to the crystals as if they had grown out from them as a base like coral growing out from a reef. At first sight this structure might be considered primary, but if crystallisation set up once more in a rock magma after it had been interrupted, there appears to be no reason why outgrowths should not be formed from crystals already in existence, just as a crystal of alum hung in a solution of alum will furnish the nucleus round which crystal deposit will take place afresh. There is no sign, however, of perlitic or other glassy structure in this rock, but it compares very closely with a specimen slide of the Lea Rock (see Teall's British Petrography, p. 340), which I have in my possession. It may therefore have suffered much more extensive devitrification than the rocks at the top of the pass.

The ground mass contains numerous small flakes of brown pleochroic mica, as well as minute grains of zircon. It has been strongly silicated, and it contains much free silica in the ground mass, and as aggregations of small crystals forming a mosaic.

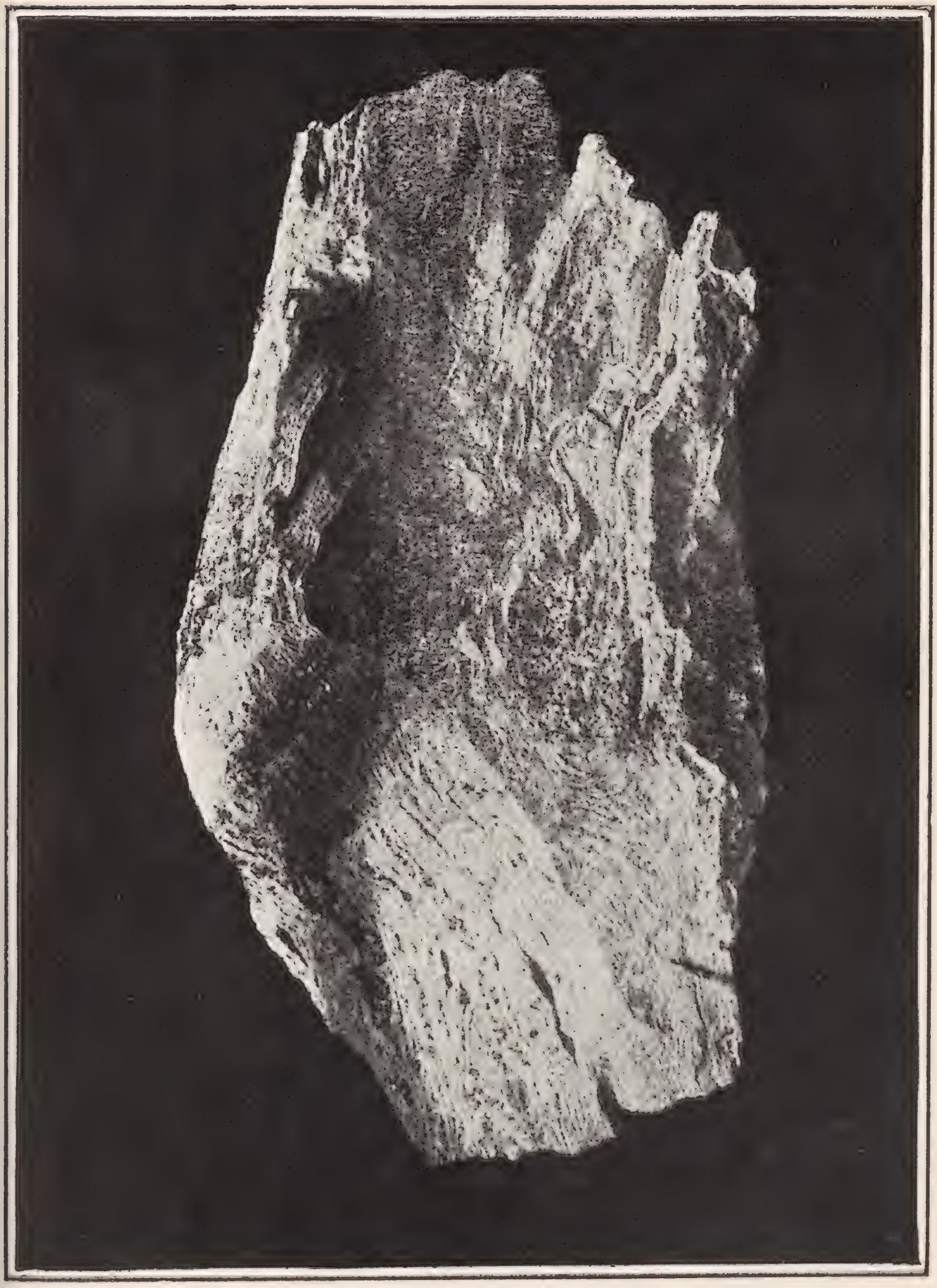
Sections made from the rhyolite of Gebbie's Knob, which is on a line with this occurrence, show a related structure. The micrographic texture of the base is at times as clear as that of the rock just considered, but at times it becomes indefinite and cryptocrystalline. The grains of quartz and of felspar are margined with this micrographic material, the distinction between the material attached to the felspar from that attached to the quartz being quite clear, since in places the relative index of refraction can be measured by Becke's method, and that of the felspar is distinctly lower. In this rock the felspar is occasionally much kaolinised, and the rock is stained brown by minute flakes of iron ore. Zircon is again present.

A similar textured rock occurs further to the east in McQueen's Valley. Almost the whole field is taken up with cloudy micrographic intergrowths, which at times take on a more or less distinct centric form. In one slide from this rock there was a marked band of crystalline material, decided coarser in texture, composed of quartz and felspar, which at times shows a radial arrangement in an indefinite manner.

PLATE XIV.

PLATE XV.

PLATE XVI.



Summary.

The general features of these rhyolites may be summarised as follows :—

1.—There is a general uniformity in chemical and mineral composition, which present no marked peculiarity.

2.—The phenocrysts are dominantly quartz and sanidine, with plagioclase in smaller amount ; biotite is the chief F. M. mineral ; garnet occurs very occasionally.

3.—The ground mass exhibits a general tendency to the formation of areas of micrographic structure, which shows progressive development from indefinite cloudy masses to decidedly clear felspar-quartz intergrowths.

4.—A glassy ground mass occasionally occurs, which has become more or less devitrified with the formation of spherulites.

5.—From the uniformity of the chemical composition of the rocks, even of those that exhibit marked silicification, it must be inferred that the silicification took place as the rocks were cooling after extrusion, or that the hot water, which may have been introduced by subsequent volcanic action in the area did not add any foreign silica, but merely redistributed that already present. In the case of the Quail Island spherulitic rhyolite some silica and other constituents appear to have been added.

EXPLANATION OF PLATES.

Plate XIV.—Part of the foreshore of Quail Island, showing rhyolite with lithophysæ forming the bulk of the rock.

Plate XV.—Closer view of the rock shown in Plate A, giving lithophysæ in more detail.

Plate XVI.—Banded spherulitic rhyolite, Gebbie's Pass, showing tortuous sub-parallel layers ; photo from hand specimen.

NOTE ON THE ORIGIN AND STATE OF THE HERBARIUM

By Arnold Wall, M.A., Hon. Curator of the Herbarium.

The collection and preservation of the native plants was begun by Sir Julius von Haast during his period of Directorship of the Museum. While the best part of his collections were sent to England, and remain there, a certain proportion were placed in the Museum. During his travels in the Alps between 1862 and 1880 he deposited many specimens here, and these form the foundation of the Herbarium as it is now. During 1877 a visit was made by him and his family to Hanmer, and a large number of the commoner species of that district were collected, dried, and mounted for the Herbarium by his son Heinrich, then a boy. Lady von Haast also collected some of the ferns which are now in the Museum.

The chief contributors to the collections before 1900, besides Sir Julius von Haast, have been J. D. Enys, T. Kirk, T. F. Cheeseman, and an unnamed contributor residing at Cheviot, who seems to have been a Mr. Wilkinson. A few important specimens were also given by R. Brown and J. B. Armstrong.

Unfortunately for us most of the plants collected by J. D. Enys at or near Castle Hill were sent away either to England or to Mr. T. F. Cheeseman, with whom he made annual excursions in the Craigieburn Mountains for some years. In the eighties, however, Enys visited the South-West Fiords, and a number of plants collected by him on that expedition, chiefly in Resolution Inlet, were given to us.

Kirk's contributions are very numerous, and of very great value. The best of them are from the North Island, and his specimens of the trees and shrubs of the Northern Forests make, in fact, a fairly complete collection. All Kirk's specimens are beautifully prepared and mounted, but it is a pity that his labels give very little detail as to locality and none as to dates. Through Kirk a good many fine specimens reached us from Mr. T. F. Cheeseman, and these are greatly prized.

In more recent years, before the appointment of an Honorary Curator, the Herbarium received from time to time contributions

of great value from Messrs. D. Petrie, R. M. Laing, and Dr. L. Cockayne. On the appointment of the Curator these gentlemen and some others were approached, and a very large number of specimens were obtained from all of them. The chief of our benefactors has been Mr. D. Petrie, now of Auckland, who has presented us with many hundreds of beautifully prepared specimens of northern plants, especially strengthening the collection where it was formerly most weak, *i.e.*, in the Cyperaceous and Gramineous departments. Very large donations were also made by Mr. T. F. Cheeseman and Mr. R. M. Laing. Dr. L. Cockayne gave up several days to the examination and selection of specimens from his own Herbarium, together with the Curator, for our collections. We have also received very precious contributions, especially of ferns and Cyperaceous plants from Mr. H. Carse, now of Auckland, formerly of Kaiaka, and very fine suites of Orchids from Mr. H. J. Matthews, formerly of Kaitaia, now of Auckland.

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ARCHÆOLOGY OF CANTERBURY.

By H. D. Skinner, B.A.
Lecturer in Anthropology, Otago University.

MOA-BONE POINT CAVE.

Plates XVII.—XX.

In various parts of New Zealand—Whangarei, the Gisborne district, Canterbury, and Otago—ancient camps have been excavated by competent excavators, yielding evidence that there the moa had been killed and eaten (1). References to reports on many of these sites, with diagrams and illustrations, are given in the bibliography at the end of this paper. These sites have yielded evidence not to be gainsaid that the earliest inhabitants of New Zealand hunted, and finally exterminated some of the smaller species of moa. Hence the artifacts found in Moa-hunters' camps should constitute evidence of prime value in determining the nature of the material culture of the most ancient inhabitants of New Zealand. The first theory as to this ancient culture which attained prominence was that of Sir Julius von Haast, who held that it was palæolithic, and hence that it differed fundamentally from the neolithic culture of the Maoris. But following his excavation of the Moa-bone Point Cave he abandoned this view, and adopted, with unimportant reservations, the view of his opponents, among whom Professor F. W. Hutton, F.R.S., and Alexander McKay were prominent. The prevailing view for more than a generation was that set out by Hutton in his classic paper (2), namely, that some of the smaller species of moa were actually contemporary with man, and that the Moa-hunters were culturally indistinguishable from the tribes whom Captain Cook found in possession. Hutton held the view that the date of final extinction was not later than some centuries ago.

Within the last few years a new theory as to the earliest inhabitants of New Zealand has gained wide acceptance. It is based on traditional information published by T. Whatahoro (3), and it owes its general acceptance to its adoption by the most eminent of the older generation of ethnologists. Whatahoro's informants stated that the earliest inhabitants were of a physical type which, in truth, exists nowhere on the globe, and that they were in the lowest stage of culture. These people are usually styled Maruiwi, and those who accept them as historical affiliate them to Melanesia, both in race and culture. The Morioris of the Chatham Islands and the Ngati-mamoe, an ancient tribe of Canterbury and Otago, are both stated to be of Maruiwi descent. But Moriori evidence is in flat contradiction to that of Whatahoro's informants.* Hence

(Note.—*The Moriori evidence will be set out in a forthcoming memoir from the press of the Bishop Museum, Honolulu).

it becomes a matter of great importance to Maori ethnology, indeed to Pacific ethnology in general, to ascertain whether the theory of Whatahoro receives support from excavated sites in Canterbury and Otago, the ancient home of Ngati-mamoe, or whether the data supplied by these sites supports Hutton's view.

Moa-hunters' camps appear to have been fairly numerous in Canterbury and Otago, but most of those thus far discovered have been ruined either by incompetent digging or by failure to place results on record. There are, however, three sites which provide decisive evidence as to the culture of the Moa-hunters. They are Moa-bone Point Cave, Monck's Cave, and the Shag River sandhills. The largest of these is the last-named, which will be described by Mr. David Teviotdale and the present writer in the forthcoming issue of the Journal of the Polynesian Society. The original descriptions of the finds made in both the Canterbury caves left much to be desired. Professor Speight therefore invited me to go through the whole of the material recovered from them, which forms an important part of the Maori Section of Canterbury Museum, and to re-describe it. The material was sent to Dunedin, where it was examined and described, and a detailed description was returned with the material to Professor Speight. The present paper is intended to summarise the detailed account, and to provide illustrations and data, which may be used by students for comparative purposes. I owe my sincere thanks to Professor Speight for his generosity in giving this opportunity of working over such interesting and important material, in sending it to Dunedin, and finally in finding an avenue of publication in the Records.

The Moa-bone Point Cave was excavated under von Haast's direction in the spring of 1872. He himself spent little time at the excavations, depending for his data on his two workmen, one of whom was Alexander McKay, destined in after years to make great contributions to the science of geology in New Zealand. Into the dispute that arose between McKay and von Haast as to the interpretation of their finds it is not necessary to go, beyond noting that as a result of it we have two fairly full accounts of the excavations (4).

Von Haast states that the cave had its origin in a gigantic bubble in one of the lava flows which poured north from the Lyttelton crater. The bubble was broken into by the sea, and considerably enlarged by wave action at a time when open ocean rolled where now stretch the flats and sandhills of the Heathcote estuary. At that time, when, in von Haast's opinion, Banks Peninsula was still an island, some twelve feet of marine sands were washed into the cave, forming the lowest stratum of the deposits which partly filled it. Above these sands von Haast distinguished two beds, which

he named "the Moa-hunter beds," and "the Maori beds." It will be convenient to discuss these three deposits and their contained remains in order from below upwards.

I.—THE MARINE SANDS.

"This bed," says McKay (p. 99), "contained great quantities of bird bones of small size, and many seal bones, some of rare or unknown species, together with a few flints and a piece of obsidian, evidently here through human agency." Anyone who has dug in marine sands will, I am confident, conclude from these contained remains that the excavators mistook blown sand for sand laid down by the waves. McKay continues :—"The chief interest attaching to this bed is the occurrence of a human jaw, and one of the principal bones of the heel. The jaw was found buried six inches beneath the surface of the sand, and immediately below the remains of a seal which and evidently been stranded there. . . The human bones were found in a purely undisturbed locality." Unfortunately the human heel-bone, flints, and the piece of obsidian have all been lost. It is remarkable, also, that none of them are mentioned by von Haast. The "human jaw" is part of the right lower mandible with part of the ascending ramus. The sockets of the two premolars, and of three fully-developed molars are preserved, but the teeth are missing, except the roots of the third molar. The bone nowhere shows any sign of abrasion by sand or gravel. Among the fire-sticks from this cave is one labelled in von Haast's hand, "Marine sands." As neither von Haast nor McKay mentions such an article as being found in these sands it is to be presumed that this is a clerical error.

In view of all these difficulties it is to be regretted that neither von Haast nor McKay has stated the reasons for assigning a marine origin to these sands, more especially when it is remembered that the acceptance of such an origin involves the acceptance of a much earlier date for the first human occupation of New Zealand than is warranted by such other evidence as we have at present.

II.—THE MOA-HUNTER BEDS.

Above the "marine sands" there followed a succession of strata, divided into two series, a lower, called by von Haast "the Moa-Hunter Beds," and an upper, which is called "the Maori beds." The Moa-hunter beds averaged a foot in thickness, and contained many bones of moa and other birds "chips of wood, fragments of nets and matting, tools of wood and stone, quantities of grass and fern." (McKay, p. 100). McKay calls this deposit "the dirt bed." "A notable feature of this dirt bed was the almost entire absence of the remains of shell-fish, which are so plentiful in the overlying beds, a peculiarity so striking as to be evident at a glance in the sectional trenches."

Artifacts from the Moa-Hunter Beds.

It is most unfortunate that few of the articles collected in the cave have, at the present time, any marks indicating the bed from which they were derived. As, however, at least two quartzite flakes, which must have come from districts more than a hundred miles to the south, are marked "Dirt bed," it is likely enough that some of the flakes from districts to the north are from the same horizon.

A.—Stone Implements.

Adze (Plate XVII., fig. 1-1a).—This is labelled in McKay's hand, "Under breccia, disturbed," while in another hand, presumably von Haast's "In oven." Von Haast describes it as belonging to the Moa-hunters. "This oven," he says (p. 71), "was excavated, used, and filled up again with the remnants of the meals, and of the usual occupations of the Moa-hunters before the dirt and ash bed was formed above the agglomerate. On the bottom of this oven a polished chisel of dark chert" (more correctly a basalt adze) "was discovered 4.8 inches long by 1.51 inches broad. . . . I obtained this information from the workmen . . . but I think it can be accepted as reliable, as I cross-examined both men, and found their accounts to agree in every particular." McKay's account (p. 100) is different :—"In front of where the door of this house should have been, in a hole dug through the dirt bed, and underlying the agglomerate, lying directly on the sands, I found a well-polished stone chisel." The evidence, though not quite conclusive, thus indicates a Moa-hunter date for the adze. It has the plane surfaces and defined edges typical of Polynesian implements of this class.

Fragments of Polished Stone Implements.

Seventeen of such fragments are recorded by von Haast, but as they have not been labelled nothing can be said about them.

Cores, Chips, and Flakes of Various Kinds of Stone.

Von Haast lists all these as from the Moa-hunter horizon. If this is correct, the Moa-hunters must have been in frequent communication with districts distant to north and south. The obsidian was probably derived from Mayor Island in the Bay of Plenty ; the flint is probably from the Amuri Bluffs ; while quartzite is not found nearer than South Canterbury. Two of these flakes, apparently flint, are important as showing fine steep retouch, in the manner of the European Stone Age (Plate XVIII., figs. 1 and 2).

B.—Bone Objects.

Canine Tooth, bored for Suspension (Plate XVIII., fig. 4).—This appears to be a seal tooth. The drilling of the perforation is extremely neat.

Bone Implement (Plate XVIII., fig. 3).—Such implements are usually described as "fish-gorges"; gorges of this type occur in various parts of the world, and in the Pacific are recorded from the New Hebrides. They are very common on Otago sites.

Bone Needle and Flax Cord (Plate XVIII., fig. 5).—Von Haast states that the needle, which is 25.5 cm. in length, is made from the humerus of *Macronectes* (*Ossifraga*) *gigantea*, the Nelly. Both ends are broken, and no attempt has been made to grind or sharpen either; 3.5 c.m. from one end a hole has been drilled, through which the three-ply cord was passed. It is to be supposed that one end of this cord was knotted close against the head of the needle to prevent slipping, while the free part of the cord emerged from the hole. The cord, which is much frayed, is about 50 cm. in length.

C.—Wooden Implements.

Fire-making Apparatus.—To this heading von Haast assigned ten pieces, of which, however, only three are undoubted fire-sticks. The one labelled "Marine sands" has already been mentioned. It may be noted here that this piece has been used both as "plough" and as "bed," indicating that the Maoris would use the same kind of wood for either purpose. Two pieces, one a "plough," and the other perforated by a small drilled hole, were described by von Haast as apparatus for making fire by the "fire-drill" method. If this description were accurate we would have to admit that in at least one important cultural feature the Moa-hunters differed from the Maoris. Hutton has shown (5), however, that von Haast was incorrect.

The remaining objects of wood from the Moa-hunter beds are too fragmentary to admit of identification.

D.—Articles Made of Flax.

McKay mentions fragments of nets, but as none are labelled they cannot now be distinguished.

Species of Moa Represented.

Von Haast does not state how many individual moas were represented in the Moa-hunter beds, but the following is his determination of species (arranged in order of frequency of representation):—*Meionornis didiformis, Euryapteryx rheides, E. gravis, Palapteryx crassus, Meionornis casuarinus, Dinornis robustus, Aptornis otidiformis, A. defossor.* It will be seen that small species

strongly predominate. The following bones of *D. robustus* from the Moa-hunter beds are reported by von Haast: portion of the pelvis, two ribs, five vertebrae, right femur, and portions of the tibia and metatarsus (broken for the extraction of the marrow). This is the sole evidence that any of the species of the genus *Dinornis*, which includes all the larger moas, was contemporary with man. Von Haast states (p. 70) that *D. ingens* was represented in the Moa-hunter deposits at the Rakaia mouth, but Hutton (6) states that this is a North Island species never found in the South. As von Haast was thus wrong in his identification of *ingens* he may also have been mistaken in *robustus*. On this interesting and important point we must therefore await the production of further evidence.

III.—THE MAORI BEDS.

McKay states that there were two beds, a lower one varying up to five feet in thickness, and containing vast numbers of shells that had been cooked, and an upper bed containing grass and fern leaves, in which Maori and European materials were freely mixed, and varying in thickness from a few inches to two feet. "Moa bones did occasionally occur in the upper shell deposits, but they were of rare occurrence, and were undoubtedly foreign to the bed in which they occurred. I believe that the clear and distinct line of parting between the beds containing moa-bones, and the overlying shell beds (the materials of neither transgressing their proper boundary) marks a very long blank in the history of the cave, and that only the desertion of the cave during Moa-hunting times, in order to follow the game to its furthest fastnesses after its extinction from the hills of the neighbourhood, could account for the facts in a satisfactory manner. Such a radical change of food as is indicated by the deposits could not have been brought about in a short time."

Human Skeleton.—Of considerable interest is the skeleton of a man who had been buried in the sitting position with knees beneath chin, the body having been bound in that position with flax. Above the grave were some six inches of undisturbed shell-bed, indicating, as von Haast pointed out, that the cave was used only intermittently, and that a considerable interval had probably elapsed between the burial and the re-occupation of the cave.

The only available data for estimating the relative duration of Moa-hunter and Maori occupation of the cave are the depths of the two deposits. Von Haast states the former at less than a foot, while the latter range up to eight feet. McKay puts them at one foot and seven feet respectively. If, then, the rate of deposit was about the same in both, we may conclude that the period between the arrival of Europeans, and the extermination of the moa was at least seven times as great as the Moa-hunter period, and probably much more.

Artifacts Found in the "Maori Beds."

The only difference of importance between the contents of these and of the "Moa-hunter beds" is due to the change of diet already mentioned. In the newer, as in the older, beds were found the earth-oven, the bones of dog and of seal, fragments of polished adzes, and "fire-ploughs." In the Maori beds broken pieces of polished greenstone were found, but though this material was not found in the Moa-hunter deposits here, we know from the Shag River evidence that it was known to the men who hunted the moa there. Objects of bone and stone are unexpectedly rare in the collections as they now stand, but this is compensated for by numerous interesting items in wood and flax.

A.—Articles of Wood.

Four wooden fern-root beaters, the most finished of which is shown in Plate XVII., fig. 4.

Chisel Handle (Plate XVIII., fig. 6).—Length, 12 cm. Slot to hold chisel 3.75 cm. long, and about .7 cm. in diameter. Poll much battered by mallet blows. The shape of the slot seems to indicate that the stone blade was circular, probably a gouge; called *karera* by von Haast's informants.

Fish-hooks.—The largest hook (Plate XVII., fig. 3), is of unusual interest, because it retains its barbed wooden point and flax binding. Such wooden points were probably common in districts where suitable bone was scarce. In this case the base of the wooden barbed point is brought against the outer face of the distal end of the shank, and the two-ply cord is wound back and forth as in the sketch (Plate XVIII., fig. 7). The cord is then passed round shank and butt of point at right angles to the first series of turns. This process appears to have been repeated three times, in addition to which the point has been bound in with several occasional loops as convenient. The bend of the hook is scored with the marks of fishes' teeth.

One wooden shank is of the same type, but smaller (Plate XVII., No. 5).

Another, unfinished, wooden shank is similar, but slightly less curved (Plate XVII., No. 2).

The proximal end of another shank is missing. This example is straight backed, and is of the same type as a stone shank from Westland in the Fels collection, Dunedin (Plate XVII., No. 6).

Another shank (Plate XVII., No. 7) is of an entirely different type, a type which appears to have been common in Otago. Von Haast records, on the authority of two Ngati-porou Maoris, that this hook is called *manga okooko*, and that the bone point is *mata*. The

broken butt of the bone point remains fixed in the distal end of the shank. The shank is broken off at the tip where perforated for the passage of the line.

Plate XVIII., fig. 8.—Use unknown.

Plate XVIII., fig. 9.—Use unknown.

Plate XIX., fig. 1.—This is probably von Haast's "*ripipawa*, a knife made of *manuka*, to loosen *pawa* shells." It appears to be too long and slender for such a purpose. Length 20.4 cm.

Plate XIX., fig. 2—This appears to be a plug.

Plate XIX., fig. 3.—Use unknown.

Plate XIX., fig. 4.—This implement appears to be a slender beater for some delicate class of work. The distal end, which is lozenge-shaped in cross-section, and is flat-sided, is slightly frayed, as though through soaking in water, and is slightly coloured as though by some dye. It seems probable that the implement is allied to a group of wooden objects found in a cave on the Mokau River, and now in the New Plymouth Museum.

Plate XIX., fig. 5.—Foot of an adze-helve. There is a pronounced and fairly sharply-pointed heel. The bed for the adze is slightly hollowed. The shaping appears to have been done by a stone adze, the marks of which have, however, been obliterated by the use of a burnisher of irregular texture, probably a piece of coarse sandstone.

There are fragments of several wooden bowls. One is the well-curved lip of a bowl. Another is part of a flat-bottomed oval bowl. Two other pieces constitute the greater part of an oval wooden bowl about 40 cm. long by 16 cm. wide. The under-surface is curved leaving no flat base, and the vessel is prolonged at one end into a bluntly pointed handle, while at the other is what was originally a similar handle, which has since been grooved beneath, apparently to catch a looped cord. It may be that these fragments are part of a plain "feather-box," intended to be suspended from the roof, as was usual with *waka huia*. Plate XVII., fig. 8, represents part of a similar but somewhat larger vessel.

B.—Articles Made of Fibre.

Sandals.—There are three single sandals. The method of manufacture seems to be as follows:—The sole is first plaited in checker of broad strips of unscutched flax, the sole being square across the toe, and tapering slightly to a rounded heel (Plate XX., fig. 2). The wall around the heel is next plaited on to the sole. It consists of two horizontal strips of flax, the upper one about 2 cm. above the sole; within which are ends of flax-strips brought up from the structure of the sole, and acting as a pad to the heel. From the upper part of each of the substantial knots securing these horizontal

flax strips to the sole there runs forward a stout, slightly rolled strip of flax, which is caught on to the side of the sole twice, forming two loops. The ends of these strips are then laced back, each through the loops on the opposite side of the sole. In all three examples the principal wear is on the heel. They are made in just the same way as the Otago Maoris still make sandals, except that the Otago product is not so stout, and has a loop in the middle of the toe-margin, which catches the laces before they pass back to the heel.

FRAGMENT OF NET WITH PUMICE FLOAT (Plate XVII., fig. 9).—Diameter of float 8 cm. This type of netting was in use in Otago, and apparently throughout the North Island. Another piece of net similarly made, but of much smaller mesh was found in the cave.

FRAGMENTS OF KETE.–One of these flax bags is almost complete, though very rotten. Originally it measured about 20 cm. long by 26 cm. deep. It is made in the checker pattern ordinarily used by the Maoris when making *Kete*, and has running diagonally across the side two bands of black strips. Apparently there was originally a series of small loops around the mouth.

SHELL TRUMPET.—Von Haast has the following note :—" *Putatara,* small trumpet, blown by the mouth, made of a *Struthiolaria* shell, with an opening at the point." This diminutive trumpet cannot now be traced. The wooden mouthpiece and the flax lashing were absent, having, perhaps, decayed away. A similar but larger shell trumpet from Otago, also lacking the mouthpiece, is in the Otago University Museum. The example which Cook collected at Queen Charlotte Sound during his second voyage, and figured in the account of that voyage, is now in the University Museum at Cambridge. This example indicates that the wooden mouthpiece used in the South Island was similar to that in the North, having a janus-head ornament.

Plate XIX., fig. 6.—Unfinished example of an enigmatical class of objects known to collectors as " cotton-reels." They are made in two distinct sizes, a larger, of which this is an example, and a smaller, which appears to have been used as a pendant. An old Taranaki Maori stated that the larger stone examples were used as drill-weights, the wooden shaft of the drill being passed through the hole in the long axis of the " reel." Such a weight would obviate the wobble unavoidable when a pair of heavy stones were used, and would no doubt be useful in such delicate drilling as that required for fine bone needles. The type occurs throughout New Zealand, and has been reported from the Chathams.

McKay's statement that moa-bones were found in the Maori beds is of interest, and it may well be asked why he did not think it necessary to explain their occurrence there. It is probable that he clearly realised, though he did not formulate, the explanation.

In true Moa-hunter deposits bones from every part of the moa skeleton are found. After its extermination such of its bones as were suitable for manufacture into fish-hooks or other implements were still collected by the Maoris even as late as the period in which Dieffenbach (7) and Hochstetter (8) travelled in New Zealand. Hence the finding of moa leg bones unaccompanied by such bones as ribs or vertebrae is not to be regarded as proof that the stratum in which they are found is of Moa-hunter date.

Wooden Decorative Comb.

(Plate XX., fig. 1).

Maximum length, 27 cm.; maximum breadth, 5.75 cm. The wood from which it is made is *Totara*.

The exact locality of this very interesting comb, and the circumstances of its discovery are not on record. It is described as from Sumner. The dirt which still adheres in cracks and angles indicates that it was found below the surface, and the blow which split it has left a deep dent, suggesting the corner of a spade. It seems not improbable that this piece was obtained in Moa-bone Point Cave by unauthorised diggers, some of whose finds (*e.g.*, Plate XIX., fig. 6) have only recently (after fifty years) been secured by the Canterbury Museum.

The notched ornamentation around the opening in the body is generally described as "Archaic Maori." The two small human faces are realistically carved, but the eyes are omitted.

The type is, so far as present evidence goes, unique in New Zealand. Its nearest, though still distant, relative appears to be a form represented by a fragment from Monck's Cave, Sumner. The Edge-Partington Album affords no evidence of relationships beyond New Zealand. There is, however, a recently acquired wooden decorative comb in the Otago University Museum, which appears to be related, though lacking the heads, the notched ornamentation, and the opening in the body. The locality is unknown, but the workmanship suggests north-west Polynesia.

The comb has been figured by Hamilton (Dom. Mus. Bullet 2, fig. 72), who erroneously describes it as an eel-fork from Otago.

Conclusion.

The principal conclusions that may be drawn from the excavations at Moa-bone Point Cave are as follows :—

1. If the lowest beds in which human remains were found were correctly described as marine sands, then we have evidence of the considerable antiquity of man in New Zealand. But there are grounds for doubting this description.

2. The relative depths of the deposits indicate that the period which has elapsed since the extermination of the moa is at least seven times as long as the Moa-hunter period.

3. There is no evidence that the culture of the Moa-hunters differed from that of the later occupants of the cave, nor that the cave was ever occupied by representatives of Whatahoro's "Maruiwi," nor that the culture of Ngati-mamoe, to whom the greater part of the deposits must be due, differed in any important feature from that of the tribes who preceded or followed them.

4. Moa bones of kinds providing suitable material for the manufacture of hooks and similar implements were collected for use by the Maoris even in the early European period, and this sufficiently explains the bones mentioned by McKay as occurring in the Maori beds.

5. Further evidence is required before the contemporaneity of man and the Dinornithidæ can be regarded as proved.

(It is proposed to describe the material found in Monck's Cave in the next issue of the Records).

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8. Hochstetter, "New Zealand," p. 184.

EXPLANATION OF PLATES.

(The scales to the figures represent inches).

PLATE XVII.

Fig. 1-1A—Small adze of Polynesian type. Moa-hunter beds.
Fig. 2—Unfinished wooden shank of composite fish-hook. Maori.
Fig. 3—Composite fish-hook with wooden shank. Maori.
Fig. 4—Wooden beater. Maori.
Fig. 5—Curved wooden shank of composite fish-hook. Maori.

Fig. 6—Straight-backed wooden shank of composite fish-hook. Maori.
Fig. 7—Wooden shank of composite fish-hook. Maori.
Fig. 8—Part of wooden bowl. Maori.
Fig. 9—Pumice float and fragment of net. Maori.

Plate XVIII.

Fig. 1—Flint scraper, with steep retouch. Moa-hunter.
Fig. 2—Flint scraper, with retouch. Moa-hunter.
Fig. 3—" Fish-gorge." Moa-hunter.
Fig. 4—Seal-tooth pendant. Moa-hunter.
Fig. 5—Bone needle. Moa-hunter.
Fig. 6—Handle of chisel or gouge. Maori.
Fig. 7—Detail of Plate XVII., fig. 3. Maori.
Fig. 8—Wooden implement ; use unknown. Maori.
Fig. 9—Wooden implement ; use unknown. Maori.

Plate XIX.

Fig. 1—Wooden implement ; use unknown. Maori.
Fig. 2—Wooden implement ; use unknown. Maori.
Fig. 3—Wooden implement ; use unknown. Maori.
Fig. 4—Wooden implement ; probably a beater. Maori.
Fig. 5—Foot of adze-helve. Maori.
Fig. 6—Stone object ; probably a drill-weight. Maori.

Plate XX.

Fig. 1—Wooden decorative hair-comb.
Fig. 2—Flax sandal.

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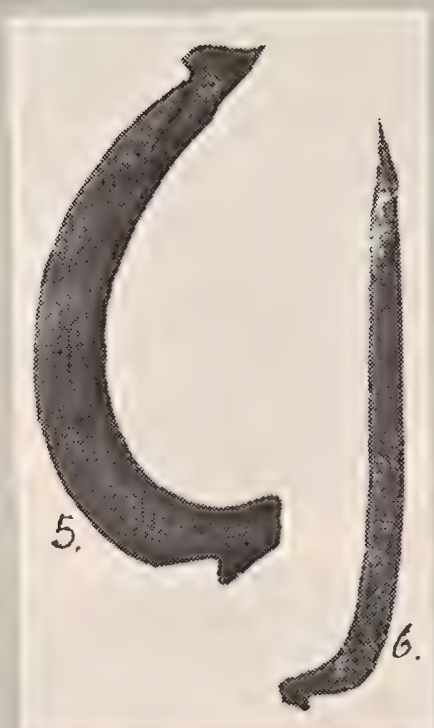
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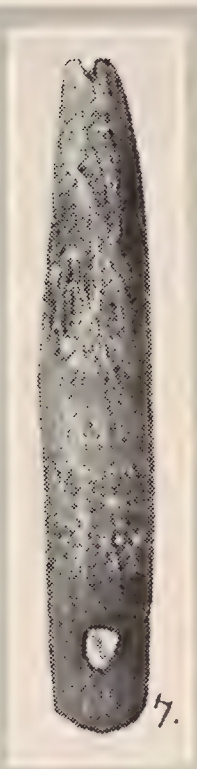
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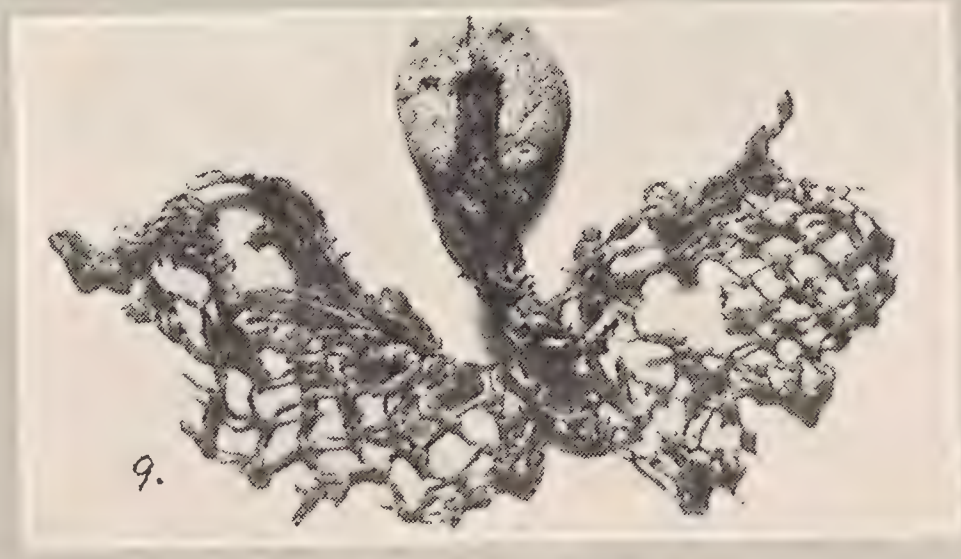
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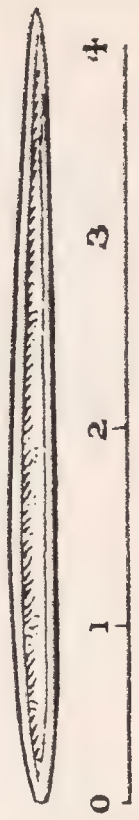

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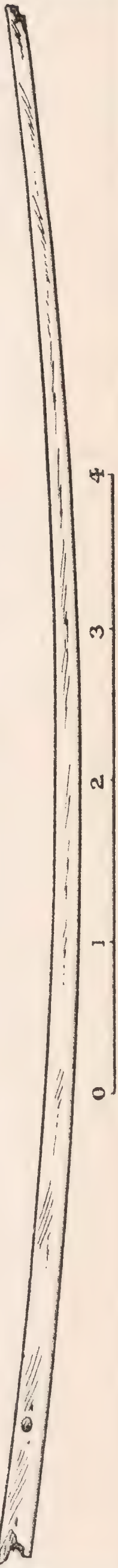

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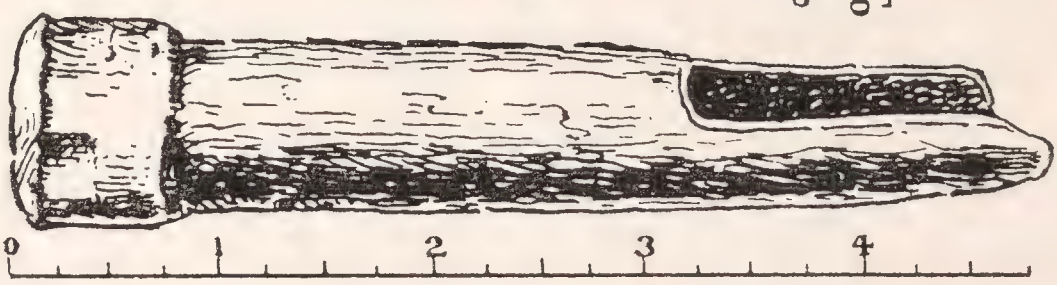

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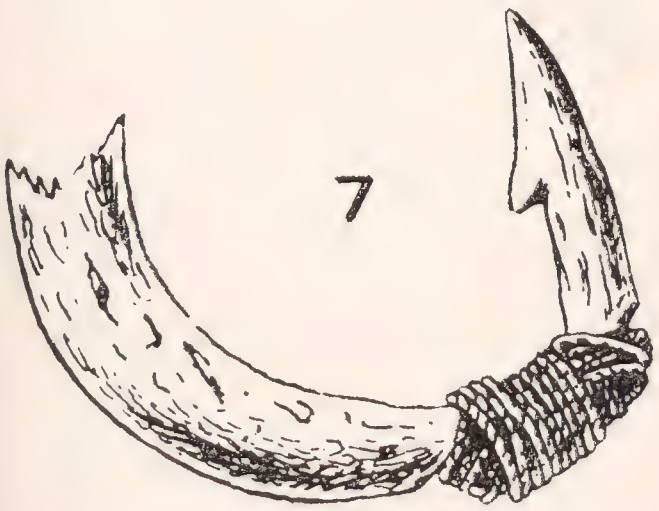

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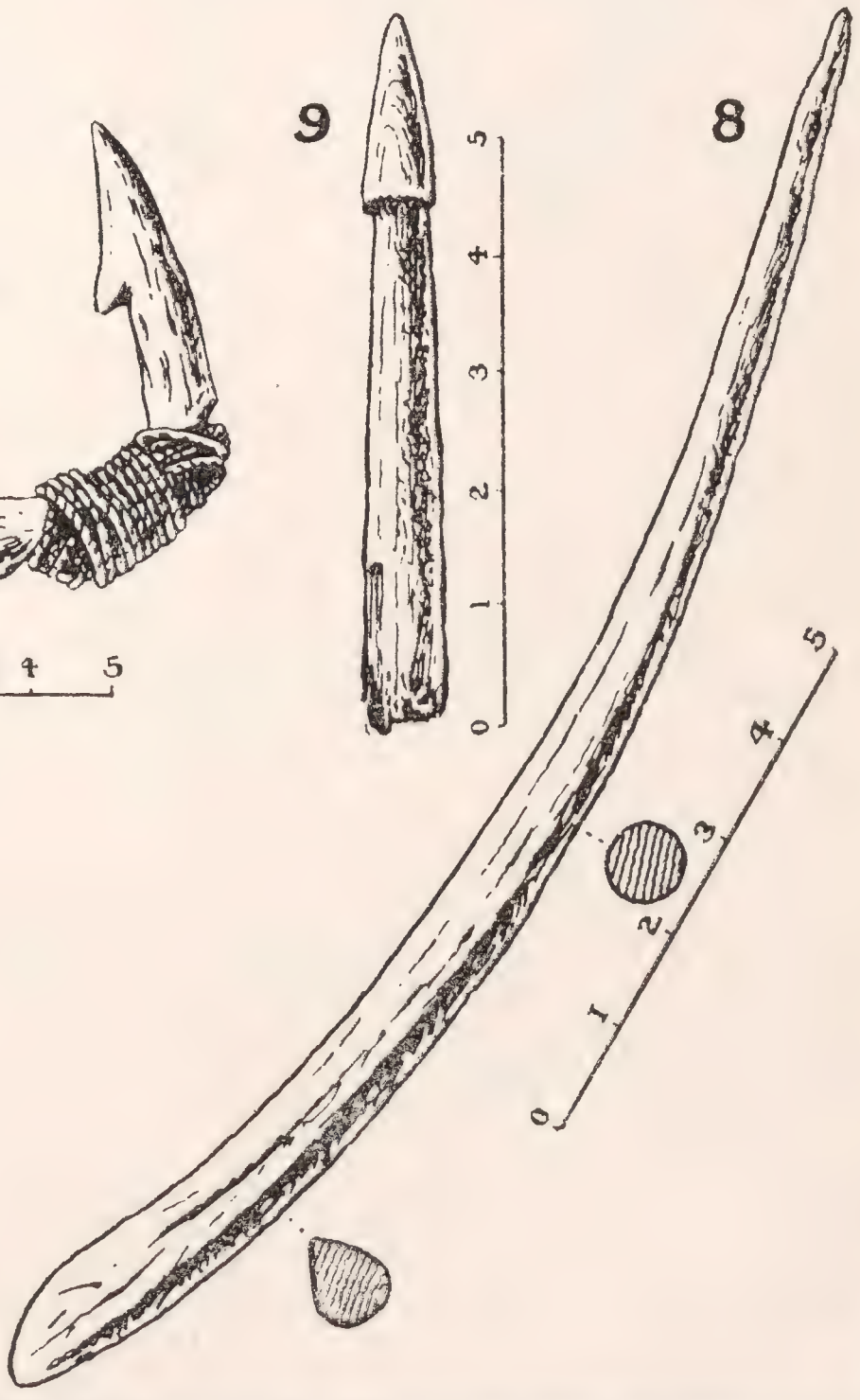

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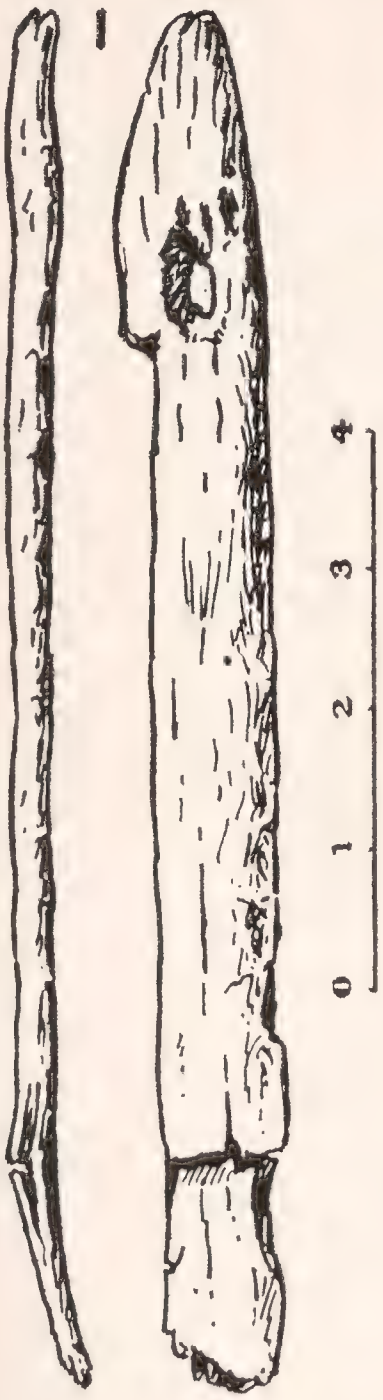
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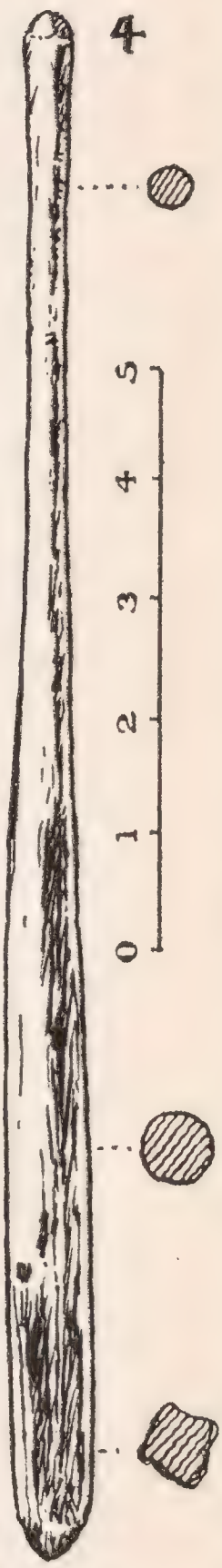
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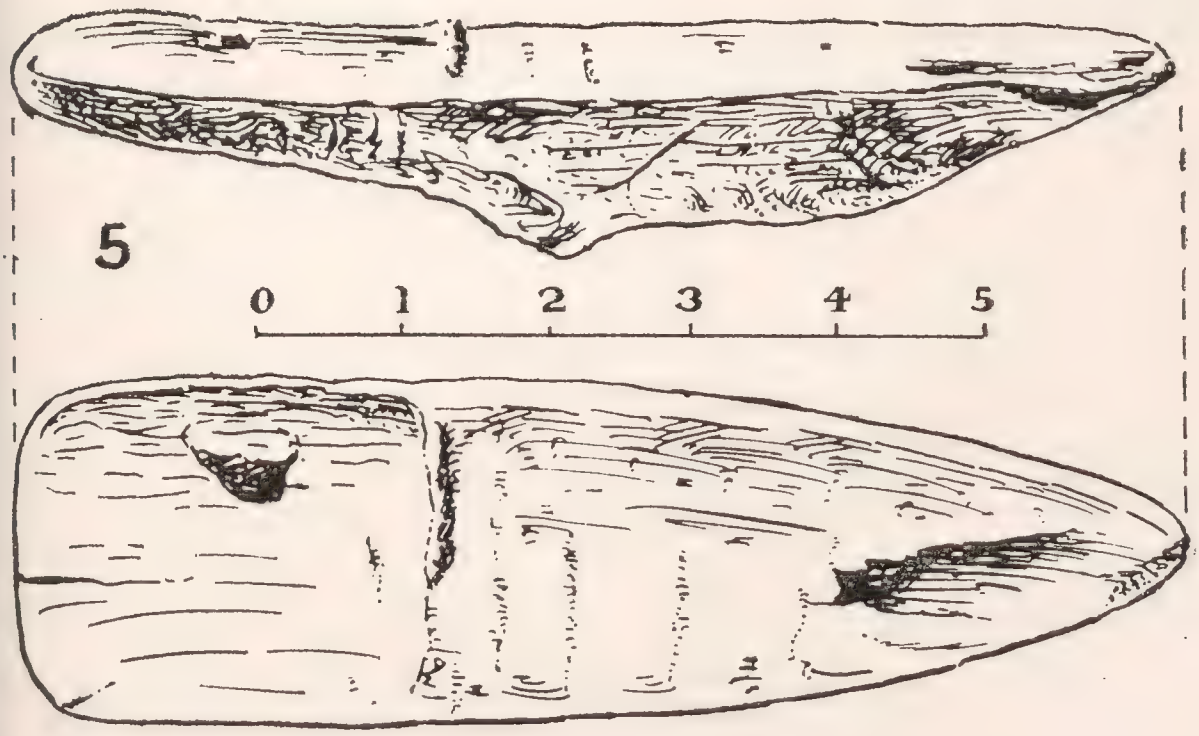
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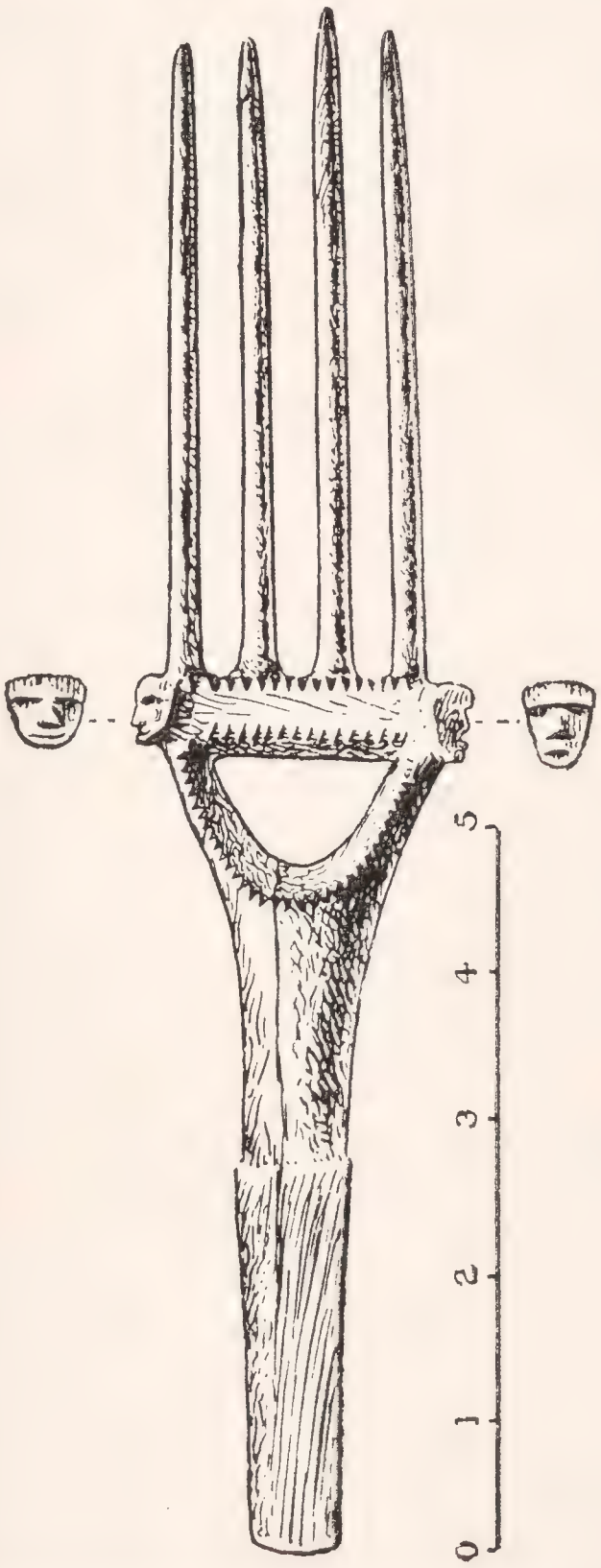

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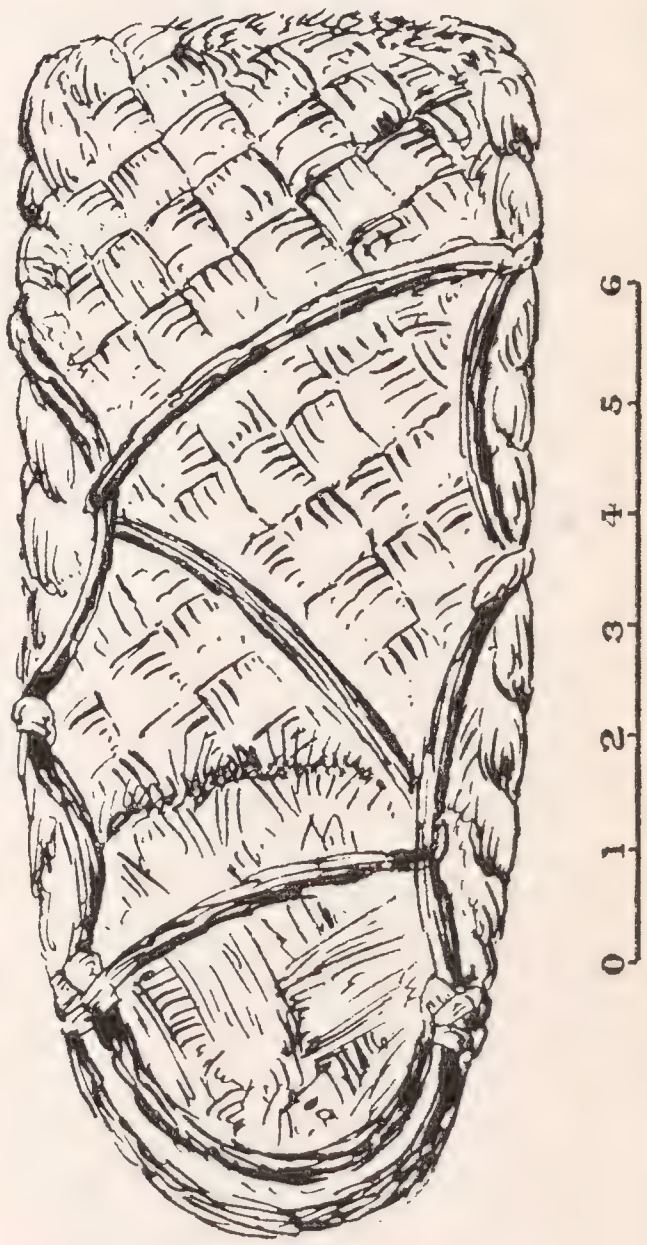


RAOULIA MAMMILLARIS HOOK F.

(*Psychrophyton mamillare*, Beauv.).

By Professor Arnold Wall, M.A.,
Hon. Curator of the Herbarium.

(Plate XXI.)

A Correction.

Raoulia mammillaris was first described by Hooker filius (Handbook, p. 150) from specimens supplied by Haast from Mt. Torlesse. The description is perfectly accurate save in one important particular, and the unfortunate mistake has misled all students of the flora of New Zealand. The plant is described as "forming large, hard hemispherical balls and patches on the ground, sometimes 8 feet long and 3 feet high." According to this description it is very much larger than even *R. eximia*, which is described as forming hemispherical cushions "2 feet high and 3 in diameter, called 'Vegetable Sheep.'" The leaf of *R. mammillaris* is described in the handbook as furnished "with a dense brush of velvety hairs on both surfaces beyond the middle; which does not exceed the tip of the leaf; whereas that of *R. eximia* bears "at the back above the middle a dense thick pencil of white velvety hairs—these bundles of hairs, meeting beyond the leaves, envelop the whole."

The Handbook does not mention Mt. Torlesse as a locality for *R. eximia*, but only "Riband-wood Range, Mt. Arrowsmith and Dobson"; this implies that *R. mammillaris* is the common plant of Mt. Torlesse, and that *R. eximia* is absent or rare in that locality.

Kirk apparently misunderstood the species altogether (Student's Flora, p. 306). He ignores Hooker's type from Mt. Torlesse, and describes a plant collected by Bryant on Mt. Starveall, near Nelson. He describes the leaves as bearing "a dense tuft of short hairs just below the tip produced beyond the margins, which are completely hidden." He also describes his plant as very large: "masses or patches from a few inches to several feet in length, and 1 foot to 2 feet high." He thought that Hooker's *R. eximia* (of Ribbonwood Range, Arrowsmith and Dobson) probably belonged to this species. He observes in a note the great confusion with regard to the habitats of the two species, and is sure that Haast's Mt. Torlesse habitat belongs to *R. eximia*, though it is the only station in the handbook for *R. mammillaris*. He regards Bryant's find on Mt. Starveall as a re-discovery, observing that no New Zealand botanist had seen it since its original discovery. A specimen sent to him from Kew as *R. mammillaris* he found to be *R. eximia*. The descriptions of Hooker and Kirk agree in respect of the white radiating tips of the inner involucral bracts which constitute an important character of the true *R. mammillaris*.

Unfortunately Kirk's specimens are no longer extant, and apparently they were not available when Cheeseman drew up his description for the Manual ; it is quite clear, however, that the Mt. Starveall plant is not *Raoulia mammillaris.* This is proved by the description of the leaf as completely hidden by the hairs, and I found, on visiting Mt. Starveall in November, 1923, that the large Raoulia there is, as I expected, typical *R. eximia.*

Cheeseman's description of *R. mammillaris* (Manual, p. 334) agrees exactly with that of Hooker in respect of the great size of the plant, " compact masses, similar in size and aspect to those of *R. eximia,*" and in respect of the inner involucral bracts, but he describes the leaf as " clothed on both surfaces with a dense tuft of straight hairs which project just beyond the tip and conceal the leaf." He observes, however, that these hairs are shorter in *R. mammillaris* than in *R. eximia,* and " do not project so far beyond the tip of the leaf."

As regards locality Cheeseman gives for *R. mammillaris* Kirk's Mt. Starveall station, and Haast's at Mt. Torlesse, and adds " Otago —Alps of the Lake District, Buchanan."

I have examined Buchanan's specimens in the Dominion Museum, and also in the Otago Museum. Those in the Dominion Museum came from Mt. Alta and Mt. Eglinton ; they are all specimens of *Raoulia eximia ;* about this there can be no doubt at all.

Beauverd includes *Raoulia mammillaris* (contribution à l'étude des Composées, 1910, p. 233) with *R. subulata, Helichrysum Youngii, Raoulia eximia, R. rubra, R. Goyeni,* and *R. bryoides* in his new genus *Psychrophyton,* as *Psychrophyton mamilare.* The specimens in the Herbarium Boissier upon which he worked were collected by Berggren on Mt. Torlesse. He observes that it seems impossible to confuse this species with *Psychrophyton eximium,* even in the absence of flowers : l'examen du sommet des rameaux stériles permet de distinguer sûrement les feuilles courtes et arrondies du P. mamillare, de celles beaucoup plus longues, linéaires, à pubescence dense et tronquée, du P. eximium." He also notices, as a hitherto undescribed character of *P. mamillare,* the presence of black glandular hairs mixed with the reddish woolly hairs (" poils laineux roussâtres.") His figure shows all the parts of the plant. The leaf is drawn with the hairs protruding beyond the tip, but not in such quantity as to conceal it. His figure of the leaf of *P. eximium* (p. 230), however, also shows the tip of the leaf not quite concealed by the hairs, which are drawn a little longer than in *P. mamillare.*

Beauverd's figures are a little misleading, for the leaf-tips of *P. mamillare* are really perfectly clear to the naked eye, as his figure of the whole branch excellently shows, so that there is a much greater difference between the two in this respect than is indicated in his plates. On the other hand, the leaves of our specimens differ

very slightly in form, while in his plates that of *P. eximium* is narrow-linear, and that of *P. mamillare* is obovate. Hooker describes the leaf of *R. eximia* as " broadly linear or obovate oblong," and that of *R. mammillaris* as " obovate cuneate or spathulate."

Miss Parlane, who drew the accompanying plates for this paper, agrees with me that the difference in shape between the leaves of the two species is very slight indeed. Probably the exact form varies according to the age of the plant, or the age of the specimen, or the part of the branch from which the leaf is taken, or the altitude at which the plant grew.

Beauverd says nothing concerning the size of the plant, presumably accepting Hooker's description, which Berggren did not correct.

It was suggested to me by Dr. Cockayne some years ago that *Raoulia mammillaris* was probably a small plant, and that the matter required investigation. Thinking that a fairly exhaustive examination of the whole Mt. Torlesse district was necessary before it could be decided that Hooker's description is faulty, I visited the mountain whenever I had an opportunity, and ascended to the various summits by way of the principal spurs, working from Porter's Pass on the South-east, Castle Hill on the West, the Broken River coal mine on the North, Patterson's Creek on the North-east, and the Little Kowai River (Mt. Torlesse Station) on the East. As this mountain (6,554 feet) extends virtually from the Rakaia to the Waimakariri, for Ben More (5,436 feet) may be considered an outlier only separated from the main mountain by the low col of Porter's Pass, this examination took some considerable time. I ascended to the summits of Mt. Torlesse and Ben More about twelve times in all, and on every occasion examined the great masses of Vegetable Sheep minutely, always hoping and expecting some day to find among them the plant which Haast discovered. It was not till late in December, 1922, that, on making the ascent from Patterson's Creek, I satisfied myself that the huge plant described by Hooker does not exist. I then brought down a plant about 8 inches in diameter, and some smaller specimens. Comparison with Haast's specimen in the Canterbury Museum and with Beauverd's specimen lent me by Mr. Petrie, showed that this was undoubtedly Haast's plant. I realised then that I had seen it very often indeed, but, like other botanists, had passed it by as *Raoulia bryoides* or some other species, since we were always seeking a very large massive plant, at least as big as *R. eximia*. I distributed specimens to Mr. Cheeseman, Mr. Petrie, and Dr. Cockayne, all of whom now agree with this determination.

In February, 1923, I visited Mt. St. Bernard (5,509 feet), about eight miles north of Mt. Torlesse, and examined most of the likely places on the whole mountain, finding *R. mammillaris* abundant in

all favourable places, but no *R. eximia* at all. I then examined Mt. Bailey (6,091 feet) at the northern end of the Craigieburn Range, about twelve miles north-west of Mt. Torlesse, where I again found *R. mammillaris* extremely abundant up to the summit, but no *R. eximia*.

In March I visited Mt. Enys in the central portion of the same range, just behind Mr. Enys' old Trelissick homestead, and here I found the conditions the same again.

In none of these places did I see any plant of *R. mammillaris* more than 2 feet in diameter, and very few indeed as large as this. Large plants are from 1 foot to 18 inches in diameter, and 6 or 8 inches high.

With regard to the leaf, I found that in all specimens examined the tips of the leaves are very clearly visible, quite as clearly as in *R. bryoides*. The thick tuft of hairs ceases some distance below the tip, which is covered with close tomentum. This point is made clear by the accompanying figures.

I hope I have now demonstrated that Hooker's description of the leaf of *R. mammillaris* is more accurate than that of Kirk and Cheeseman, and that in respect of the size of the plant all authorities have been misled by Hooker's description, based, apparently, upon Haast's observations communicated to him, as whole "Vegetable Sheep" could hardly be supplied, and that the only proved locality for it is as yet Mt. Torlesse and the neighbouring ranges.

The result of my observations, which have extended over several years, may be thus summed up: *Raoulia mammillaris* is a plant of about the same size as *R. bryoides*, not more than 2 feet or 18 inches long, and about 6 inches high. It is abundant on Mt. Torlesse from about 4,000 feet to over 6,000 feet, but less abundant and conspicuous than *R. eximia;* it is the only plant of this group present on Mt. St. Bernard (about 8 miles north of Mt. Torlesse) and on the Craigieburn Range (about 5 miles further west again), and here the plants may be counted in thousands. The leaf is exactly as described by Hooker; the hairs are comparatively short, and do not at all conceal the tip of the leaf. The species is confined to Mt. Torlesse, Mt. St. Bernard, the Craigieburn Range, and probably some other mountains in the immediate vicinity. The supposed stations in the Otago Alps and the Nelson district are recorded in error.

I desire to express my obligations to Dr. Cockayne, to whose hint the whole investigation is due; to Mr. D. Petrie, who kindly sent me Beauverd's papers on the subject; to Miss Beryl Parlane, of Canterbury College, who made the drawings for the plates; to Mr. W. R. B. Oliver, of the Dominion Museum, who saved me much time and trouble by searching Kirk's Herbarium, and preparing Buchanan's specimens for my inspection; and to Mrs. Aitken of the Otago Museum, who sent me Buchanan's specimens for the same purpose.

EXPLANATION OF PLATE XXI.

FIG. 1—Leaf of *Raoulia mammillaris* (*Psychrophyton mamillare*), showing the tip clear of long hairs, and provided only with tomentum.

(*a*) Dorsal surface.

(*b*) Ventral surface.

FIG. 2.—Leaf of *Raoulia eximia* (*Psychrophyton eximium*), showing the long hairs completely enveloping and concealing the tip.

(*a*) Dorsal surface.

(*b*) Ventral surface.

(a) Fig 1. (b)

(a) Fig 2. (b)

NOTES ON THE TYPES OF TWO TIPULIDAE IN THE CANTERBURY MUSEUM (DIPTERA).

By Charles P. Alexander, Massachusetts Agricultural College, Amherst, Massachusetts, U.S.A.

Through the kindness of Mr. R. Speight the writer has been privileged to examine the types of two species of New Zealand crane flies (*Tipulidae*), described by the late Captain Hutton. One of these is the very rare and remarkable *Tinemyia margaritifera*, a species that has not yet been sufficiently described. The second species is Hutton's *Limnophila umbrosa*.

Tinemyia margaritifera Hutton.

1900—*Tinemyia margaritifera* Hutton ; Trans. N.Z. Inst., vol. 32, p. 44, pl. 4, figs. 17 a. b.

1923—*Tinemyia margaritifera* Edwards ; Ibid., vol. 54, p. 304, pl. 29, fig. 50, pl. 33, fig. 144 (1923).

The type is a female, bearing Hudson's No. 139.

Female.—Length, excluding rostrum, 14 mm. ; wing, 12.5 mm. ; rostrum about 6.5 mm.

Rostrum nearly half as long as the body ; palpi short, borne at apex of rostrum, the segments short, subequal. Vertex between eyes narrow, at its narrowest point less than the width of the basal segment of scape. Antennae elongate, filiform, the scapal segments conspicuously wider than the filiform flagellum ; 16-segmented, the segments with scattered verticillate setae. Legs long and slender ; tibial spurs distinct ; empodia microscopic or lacking ; claws smooth. Venation : *Sc* long, extending to a short distance beyond the fork of R_{2+3}, Sc_2 at the tip of Sc_1, and subequal to it ; *Rs* long, square and short-spurred at origin, in alignment with R_{2+3} ; R_{2+3}, a little less than twice the basal deflection of Cu_1 ; *r* about its length from the tip of R_1, and beyond mid-length of R_2 ; distal section of R_2 gently sinuous ; inner ends of cells R_3, R_5 and 1st M_2 in oblique alignment ; cell 1st M_2 gently widened distally ; *m* with a slight spur jutting into cell 1st M_2 ; *m* and outer deflection of M_3 subequal ; cell M_1 long, about one-third longer than its petiole ; basal deflection of Cu_1 nearly one-half its length beyond the fork of *M*; anterior arculus lacking. Ovipositor with the tergal valves relatively short but slender.

First scapal segment black, the second segment brown ; the base and apex of the first flagellar segment, and the apices of segments two to five yellowish, gradually becoming obscured ; terminal half of the last segment orange. Legs dark brown, the femoral bases paler ; joint of the femur-tibia pale. Halteres obscure

brownish yellow, the knobs darker brown. Wings yellowish, the ground-colour almost obscured by a heavy brown ocellate pattern, the centers of the ocelli solid ; veins brownish black. General colour of thorax dark brown, the humeral region of praescutum obscure yellow. Head almost black, presumably sparsely pruinose in fresh specimens, the orbits retaining traces of this colour. Abdomen brown, the caudal margins of the segments indistinctly paler.

Polymoria marshalli (HUTTON).

1900—*Limnophila marshalli* Hutton ; Trans. N.Z. Inst., vol. 32, p. 42, pl. 4, fig. 16 (1900) ; *L. marshalli* Edwards ; Ibid., vol. 54, p. 312, pl. 29, fig. 57 ; pl. 35, fig. 159 (1923).

1900—*Limnophila umbrosa* Hutton ; Ibid., vol. 32, p. 43 (1900) ; *L. umbrosa* Edwards ; Ibid., vol. 54, p. 312 (1923).

The type of *Limnophila umbrosa,* a female, bears Hudson's No. 144e. It agrees well with Hutton's brief diagnosis, except in the following regards :—Wing shorter (about 11.5 mm. instead of 12) ; Sc_2 lies distinctly before the level of the cord ; head yellowish grey ; incisures of basal flagellar segments pale.

I would consider this as being only a heavily patterned *marshalli,* matched by others in my collection. The semi-circular fascia described by Hutton reaches its lowest point in cell *M,* which thus includes a dark marking. By Edwards' key (Ibid., p. 306) the fly would thus run out at couplet 12 instead of 13. The statement in Hutton's description that the spots at Sc_1 and Sc_2 are united refers only to a posterior fusing of the blotches, these being separated by a cream-coloured area in cells *C*, Sc_1, and 1st R_1.

As indicated by the writer in other papers, it seems that the New Zealand species of *Limnophila,* s.l., with the anterior arcules lacking, should be referred to *Polymoria* Philippi.

A NEW GENUS OF CHILOPODA FROM BRITISH GUIANA, AND A NEW SPECIES OF *WAILAMYCTES* FROM AUCKLAND ISLAND.

By Gilbert Archey, M.A.,
Assistant Curator.

Plate XXII.

Among some Chilopoda kindly forwarded to me by Miss Anna H. Taylor and Mr. Alfred Emerson of the New York Zoological Society's Tropical Research Station, at Kartabo, British Guiana, is a specimen of the family Cryptopidæ, which, although it is mutilated, having lost the last pair of legs, nevertheless shows characters which preclude its reference to existing genera. It is, therefore, placed in a new genus, which is here described.

Scolopendromorpha.
Family Cryptopidæ.

Kartops n. gen.

Body of 23 leg-bearing segments, with ten pairs of elliptic spiracles, none being present on the seventh segment.

Head overlapping first tergite ; *antennæ* of eleven long, cylindrical segments.

First tergite with a strong curved collar-sulcus, other tergites, to the 22nd, with distinct submedian longitudinal sulci, and also oblique sublateral sulci. Last dorsal plate not margined.

Prosternum of prehensors produced anteriorly into two short setigerous processes, and bearing below (*i.e.*, inwardly to) these a pair of hammer-shaped processes, extending beyond the setigerous processes.

Ventral plates with large endosternite. Longitudinal depression well marked.

Coxopleure with long, acute, one-pointed process.

Tibiæ armed dorso-ectally at distal end with a stout spine set in a socket. *Anterior tarsi* with only a faint line of weakness, not divided ; tarsi of penultimate leg divided, but not very distinctly.

Anal leg missing.

The loss of the last pair of legs makes it impossible to define the relationship of this genus to the other Cryptopidæ. It has a general resemblance, however, to *Tidops* Chamberlin, from which it differs in the number of spiracles, the presence of socketed tibial spines, and in the anterior armature of the prosternum.

Kartops guianæ n. sp. (Plate XXII., figs. 1-3).

General colour : head and first tergite dark reddish brown, remainder greenish grey, with the caudal margin of the tergites brownish ; last two tergites yellowish brown.

Head punctured, slightly wider posteriorly than anteriorly, caudal margin almost semi-circular. A pair of submedian sulci proceeding from posterior margin a slight distance forward.

Antennæ of eleven joints ; first joint wider than long, mesal margin broadly rounded ; second joint as wide as long ; third and fourth 1.5 times as long as wide ; remainder more than twice to three times as long as wide. First two joints dorsally with only a few long setæ, these being increasingly replaced through the third to the sixth (where the replacement is complete) by much more numerous shorter setæ, these shorter setæ also decreasing in size to the terminal article.

First tergite with a very distinct dark curved collar-sulcus, to the level of which the head overlaps it ; behind this is a median W-shaped sulcus, from each of the posterior angles of which goes one of a pair of submedian longitudinal sulci to the posterior margin of the tergite. Other tergites (Plate XXII., fig. 1), to the twenty-second, with distinct submedian longitudinal sulci—also on each side, laterad of these, an oblique sulcus in the anterior two-thirds of the tergite.

Last tergite with faint sulcus near caudal margin, wider than long, lateral margins slightly diverging caudad. posterior margin medianly produced, but with the produced portion truncate.

Prosternum of prehensers (Plate XXII., fig. 2) without sulci, bearing anterior proce ses as described in generic description. Joints of telopod short and broad, not armed, but bearing several long strong setæ mesally, claw short and stout.

Sternites (Plate XXII., fig. 1) with large endosternite, well marked off by a transverse sulcus from the sternite, extending backwards under the sternite for one-third the length of the latter. Longitudinal depression distinct, transverse, at the level of the posterior third, much fainter ; two very distinct longitudinal lateral sulci separating off a narrow area at each side of the anterior portion of the sternite.

Anal sternite as wide as long, without sulci, lateral margins slightly convex and converging caudad, caudal margin strongly emarginate, with lateral angles rounded.

Process of coxopleure long, acutely 1-pointed, the point bearing at the tip a couple of fine hairs ; dorsal surface of process bearing three long setæ, ventral border with the same number, and 5 on the caudal margin of the coxopleure. Pores numerous, moderate-sized, evenly covering the whole of the surface of the coxopleure.

Spiracles broadly elliptic.

Tibiæ with a dorso-ectal spine distally at least to the fifteenth legs (Plate XXII., fig. 3) not on antepenultimate or penult legs ; other legs not known.

Antepenult legs with undivided tarsus, but line of weakness more distinct than on anterior legs ; no spines ; supplied ventrally with very long strong setæ, which become successively slenderer on distal joints.

Penult leg with tarsus divided ; no spines, but with long strong setæ.

Length 30 mm.

Locality—Kartabo, Bartica District, British Guiana, 1920.

EXPLANATION OF PLATE XXII.

Fig. 1—*Kartops guianæ* n. sp. sixteenth sternite, pleurites and tergite.

Fig. 2—*Kartops guianæ* n. sp. Prehensors.

Fig. 3—*Kartops guianæ* n. sp. fifteenth leg, ectal view.

LITHOBIOMORPHA.

FAMILY HENICOPIDÆ.

Wailamyctes munroi n. sp.

Colour : above brown, head, first tergite and thirteenth to fifteenth tergites deep reddish brown ; ventral surface slightly lighter in corresponding regions.

Head rounded, posterior border margined and slightly emarginate ; cervical sulcus distinct, a pair of large eyes present. *Antennæ* 19 joints, which are longer than wide, the last joint a little longer than preceding ones.

Tergites.—Anterior major tergites (1—5) laterally and caudally margined, the margining less definite medianly on caudal borders, which are also emarginate. Posterior major tergites margined laterally, and on rounded postero-lateral angles, but not on caudal border, which is emarginate. Minor tergites with lateral border margined, posterior border emarginate.

Spiracles on segments 1, 3, 5, 8, 10, 12, 14 ; in the form of a very narrow slit on a round eminence.

Prehensors.—Prosternum produced considerably forward, production narrowed anteriorly, anterior margins separated by a deep indentation, which is continued as a strongly marked median sulcus to posterior margin. Dental edges straight, mesally inclined, each with five distinct teeth, decreasing in size from without inward.

Sternites.—Anterior and posterior margins straight, sides converging caudad, strongly emarginate on anterior segments, but straight on the last six.

Coxal pores.—$\frac{3333}{3333}$ on type and on two paratypes, $\frac{3433}{4434}$ on third paratype, the inner pore smaller than the others on each coxa.

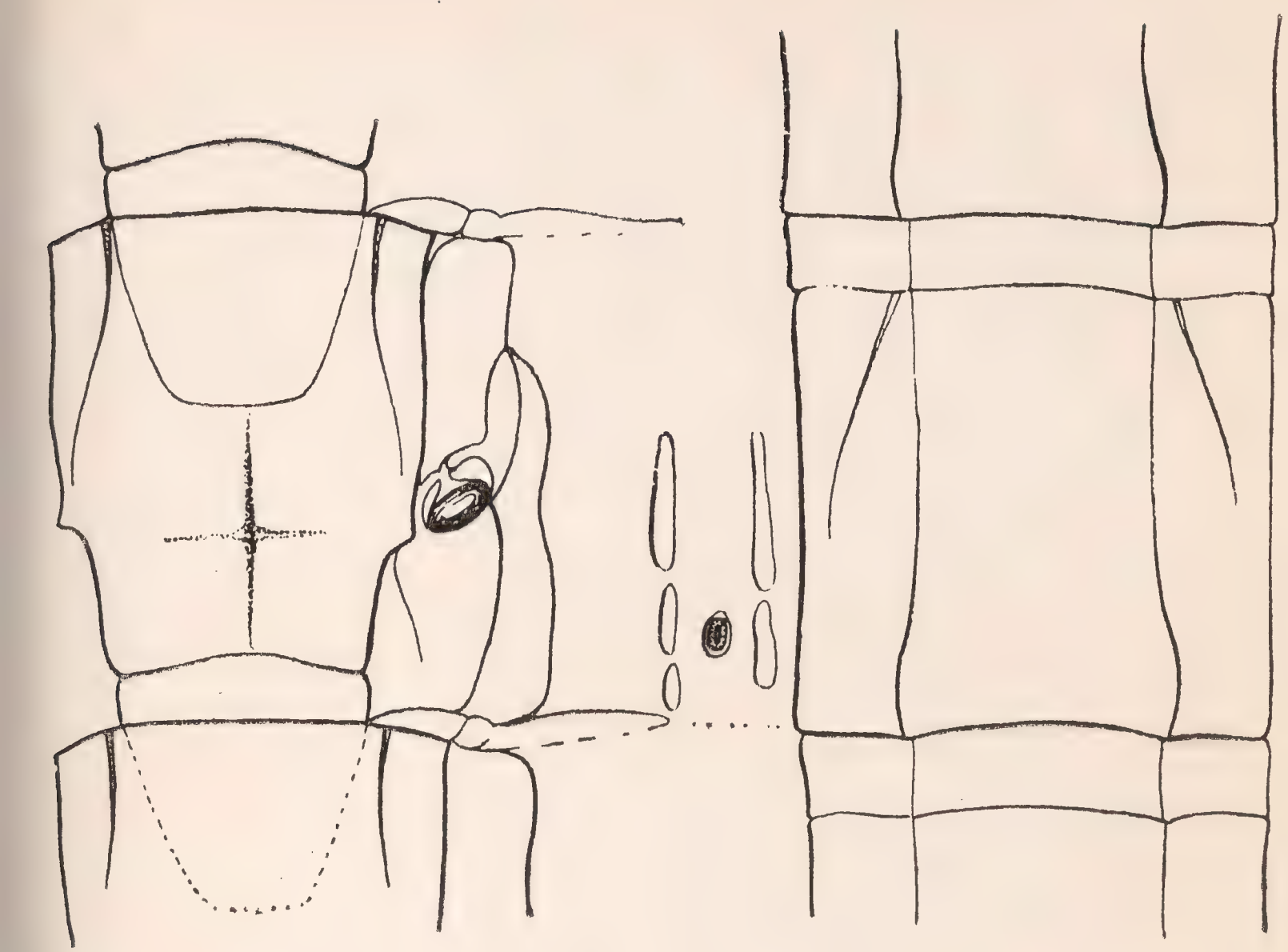
Gonopods of female of usual form, moderately with long setæ ; basal spurs stout and blunt, the outer one on each side smaller than the inner ; terminal claw short and slightly curved, a distinct suture separating it from the joint. Gonopods of male unknown.

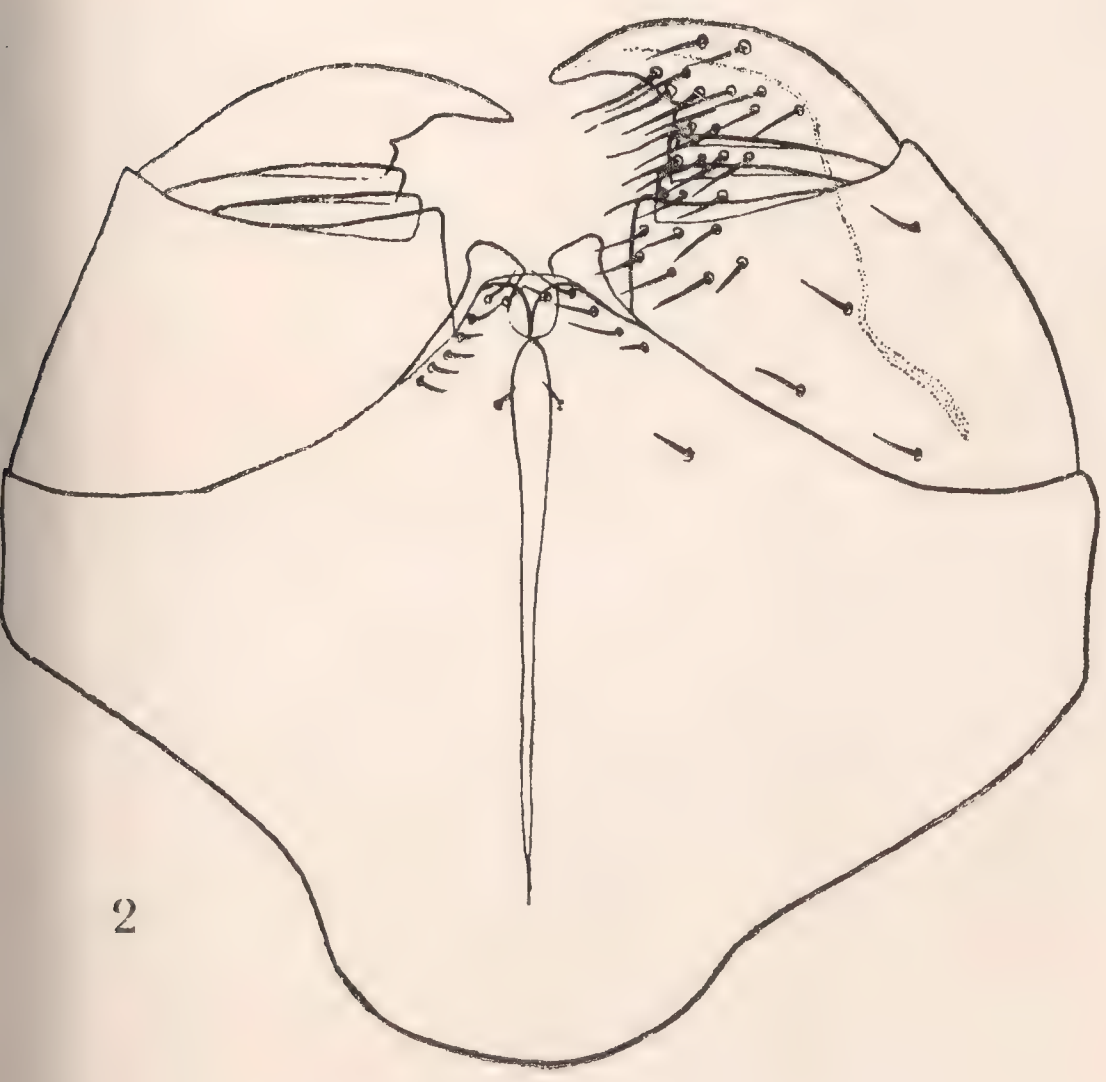
Legs.—Tarsi of 1-12 single jointed, but 11 and 12 showing a ventral weakening of the chitin, which in 13-15 shows as a well-marked articulation ; tibial spurs on legs 1-14 ; tarsi slender, that of the 10th leg ten times longer than wide, first tarsal joint of 13th eight times, of 14th ten times, and 15th eleven times longer than wide.

Length—12 mm.

Locality.—Summit of Hooker Hills (950 feet), Port Ross, Auckland Islands. (C. Munro and G. Archey).

This species differs from *W. halli* Archey in its larger size, darker colour, slenderer legs, and increased number of coxal pores, also in the presence of a tibial spur on the 14th leg. Named after Mr. Cecil Munro, to whom my thanks are due for his assiduous help in collecting.





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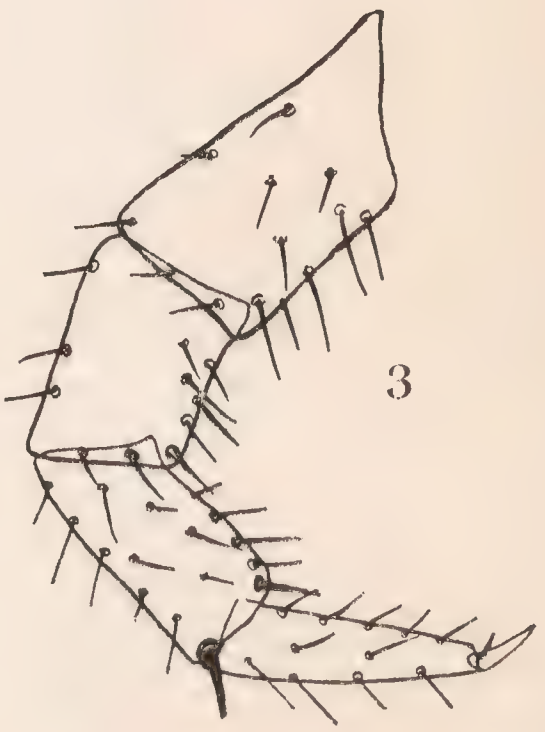

3

NOTES ON BIRDS OF THE SUB-ANTARCTIC ISLANDS OF NEW ZEALAND.

By Gilbert Archey, M.A.,
Assistant Curator.

These notes are based on observations made during a brief visit to the Sub-Antarctic Islands during March of this year. Although the lateness of the season precluded data being obtained as to the breeding habits, except in the case of one or two birds, it is hoped that records of some of those collected will be of interest.

Bowdleria punctata (Quoy and Gaimard). The Snares.

The Fern Bird seems to be no less common or tame than has been recorded by other observers. Not only does it frequent the ditches between the tall tussocks, but also flutters among the nearly horizontal trunks of the dense *Olearia lyalli* forest ; it does not, however, ordinarily fly more than three or four feet from the ground. It was commonly seen among the penguins in the inland rockeries, busily searching the ground for insects.

Nesomiro dannefaerdi (Rothschild). The Snares.

The upper branches of the sombre bush are enlivened by numbers of the little Black Robin, which is even more fearless and confiding than, say, the Fantail of our mainland bush. The absence of other passeriform birds has given the robin and the fern bird an unrestricted habitat, which, in their respective zones, they have fully occupied.

Myiomoira macrocephala (Gmelin). Auckland Islands.

Only two Yellow-breasted Tits were seen, being observed not far from the shore on Enderby Island.

Anthornis melanura (Sparrman). Auckland Island.

At Port Ross the Bell Birds were commonest among the scrub above the rata belt but in Carnley Harbour they were numerous in the forest itself ; on one occasion there were at least a dozen close around me busily brushing up insects from the twigs with their tongues. The Tui was neither seen nor heard.

Austranthus novaeseelandiae (Gmelin). Auckland Islands and Antipodes I.

The Pipits of the Auckland Islands and the Antipodes occupy the ecological position of the Fern bird on the Snares as far as the undergrowth and shore are concerned. They are common about the decaying kelp and among the penguin rookeries, as well as inhabiting the grassy uplands, where they are both numerous and tame.

Cyanorhamphus novae zealandiae (Sparrman). Auckland Island and Antipodes I.

C. unicolor(Lear). Antipodes I.

Only two Parrakeets were seen at the Auckland Islands presumably the first-named. At the Antipodes both species were fairly common but doubtless owing to the high wind were very little on the wing.

Coenocorypha aucklandica (Gray). Auckland Islands. The Snares, Antipodes I.

Only one specimen of each of the Auckland Island and the Snares Snipe was secured. Waite (Sub-antarctic Islands of New Zealand p. 556) recorded them as being abundant in 1907 on the Snares, but as I did not reach the upper table-land I cannot report on their present condition. A couple of snipe were seen by Captain Bollons on Antipodes Island.

Hypoleucus campbelli (Filhol). Campbell Island.

var. colensoi Buller. Auckland Islands.

Both these shags were plentiful at their respective stations. The difference in breast-colour distribution which distinguishes the varieties was constant for every specimen observed, and we were able to watch the birds very closely as they flew steadily over the ship.

Nesonnetta aucklandica (Gray)

The " Flightless " Duck inhabits the kelp in the more sheltered corners of the Auckland Island. It was secured at Ewing Island, at entrance to Port Ross, and just within the western entrance of Carnley Harbour. It seems to be moderately abundant. The Merganser (*Promergus australis*) was not observed.

Diomedia epomophora Lesson.

D. exulans Linne.

While many species of the order Tubinares were observed, and among them several of which further information is required, the fact that specimens were not actually taken (except in the case of the above-mentioned and *Daption capensis*), makes it desirable that they should be passed over rather than that " records " should be published without the support of the actual specimens.

The Royal Albatross was represented on Campbell Island (I did not see it at the Aucklands) by moderate numbers tending their young on the hill tops and plateaux. Mr. Manson, who was in charge of the sheep station until recently informs me that the first chicks were hatched this year on March 3rd. Young taken on the 28th March may be described as follows :—

Still fully covered with white woolly down, but with the crown and sides of the head as if cropped short. The rudiments of the primaries* are just beginning to appear. Bill pale flesh pink, tip yellowish with a dull pink flush. Total length 456 mm., tarsus 87 mm., middle toe and claw 87 mm. culmen, 87 mm.

Their crops contained fish bones, and the beaks and eyes of cuttle fish; in the stomach of one was found a parasitic nematode.

Nests of the Wandering Albatross on Antipodes I. were rather more numerous than those of the Royal on Campbell Island. The Wandering Albatross breeds later than the Royal, and the chicks were just hatching on April 1st. The down of the head of the newly hatched chick is straight, fairly close-set and white, that of the back more fluffy and vaguely grey. The bill is pale flesh pink, the tip yellowish, flushed with dull pink. Feet pale slatey grey, the webs darker. Total length, 140 mm.; tarsus, 41 mm.; middle toe and claw, 39 mm.; culmen, 37 mm.

The coloration of the sitting birds (*D. exulaus*) varied to a considerable degree. The following four stages are noted, but it is by no means possible to place the birds in four distinct groups.

1. Very dark (presumably young) forms. Crown dark brown, cheeks flecked brown and white, feathers of neck, breast and shoulders brown with white tips, feathers of back indistinctly with white.

2. Neck, throat, and crown-patch extending down the back of the neck, brown, cheeks alone pure white, a whitish band down the sides of the neck. Brown vermiculation commences on lower neck, and continues over breast, more broadly over scapulars and back.

4. A very light form. The crown patch reduced to a few brown feathers, head and neck otherwise pure white; the vermiculations of the breast of very fine brown lines, wings with a much greater proportion of white than the preceding.

Usually the darker birds had pinkish bills, the lighter forms having them dull yellowish; but the very white specimen (4) had a distinctly pale flesh-coloured beak.

Genus Eudyptes.

The Crested Penguin (*Eudyptes pachyrhynchus* Gray) was found on the Snares, both on the shore, and in numerous inland rookeries of various extent, from which the vegetation and peat had been swept clear, leaving the bare rock exposed. The birds were moulting, and in very poor condition.

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*Professor J. Cossar Ewart, who has since examined these specimens, informs me that the feathers are secondary down feathers, and that the true primaries have not yet appeared.

On the cliff faces of the Antipodes both the Tufted Penguin (*E. cristatus* Miller), and the Big Crested Penguin (*E. sclateri* Buller) occurred in immense numbers. They were not indiscriminately mixed, however, for, as reported by Waite in 1907, *E. sclateri* was found occupying all the lower levels up to about 60 feet above the beach, while *E. cristata* held the higher faces. The patchy appearance of so many heavily moulting birds was very curious, and the water of the bay in which we landed was covered by a thick scum of shed feathers. Among the Big Crested Penguins on the beach Captain Bollons secured a fine specimen of the King Penguin (*Aptenodytes patagonica* Miller).

While the ship was lying at anchor off the Antipodes Island Captain Bollons and the writer observed a partial albino swimming among a group of *E. sclateri*, and with the aid of the glasses it was observed that the head was dark and crested as usual, but the back was white, sparsely spotted with black.

In conclusion, I should like to express my thanks to Captain Bollons for the kind manner in which he made opportunities for me to land on several occasions, and to acknowledge the benefit of his wide experience of the ways and habits of the birds of the Sub-Antarctic Islands.

THE INTRUSIVE ROCKS OF BANKS PENINSULA.

By R. Speight, M.A., M.Sc., F.G.S., F.Am.G.S.,
Curator.

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A.—Introductory.

(i.) Historical and Bibliographical.

The main mass of volcanics forming Banks Peninsula has been erupted from two centres at Lyttelton and Akaroa Harbours. These consist of lava flows of the basic variety, chiefly basic andesites and basalts, while penetrating them are dykes arranged radially about the centres. but in close proximity thereto departing from this arrangement, and forming an irregular criss-cross pattern. The only other intrusives present in the area form the end of Onawe,

the pear-shaped peninsula in the middle of Akaroa Harbour. This had been believed to consist entirely of syenite, but a typical gabbro occurs associated with it. The field relations of the rocks of the area have been dealt with in a paper by the present author entitled "The Geology of Banks Peninsula" (Trans. N.Z. Inst. vol. 49, 1916, pp. 365-392), and some account of their petrology has been given by the following authors :—Filhol (1), Kolenko (2), Hutton (3), Marshall (4), Speight (5), and Bartrum (6). The present paper embodies an attempt to summarise and bring up to date our knowledge of the petrography of the district, and to give some account of the results of the author's examination of the rocks observed and collected for a number of years past. The value of this work has been materially increased by the excellent series of analyses furnished by the Dominion Laboratory through the kind offices of Mr. P. G. Morgan, Director of the Geological Survey.

(ii.) Character of the Country Rocks.

The nature of the effusive rocks of the area will be readily understood from the following typical analyses, the specimens selected for analysis being chosen so as to give as clear an idea as possible of the rocks characteristic of the area.

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(1) Filhol H.—Mission de l'lle Campbell (Paris, 1885).

(2) Kolenko B.—Mikroskopische Untersuchung einiger Eruptivgesteine von Banks Halbinsel, Neuseeland (Neues Jahrbuch für Mineralogie, Geologie und Palæontologie, I., 1-20, 1885).

(3) Hutton, F. W.—Igneous Rocks of New Zealand (Journ. and Proc. Royal Society of N.S.W., 1889).

(4) Marshall, P.—On a Tridymite Trachyte of Lyttelton (Trans. N.Z. Inst., vol. 26, 1894, p. 368).

(5) Speight, R.—On an Olivine Andesite of Banks Peninsula (Trans. N.Z. Inst., vol. 25, 1893, p. 367).
Speight, R.—On a Doleritic Dyke at Dyer's Pass (Trans. N.Z. Inst., vol. 26, 1894, p. 408).

Speight, R.—On a Soda Amphibole Trachyte from Cass's Peak, Banks Peninsula (Trans. N.Z. Inst., vol. 40, 1908, p. 176).

(6) Bartrum, J. A.—Additional facts concerning the Distribution of Igneous Rocks in New Zealand (Trans. N.Z. Inst., vol. 49, 1917, p. 418).

		1	2	3	4	5	6	7
Silica	SiO_2	50.87	50.33	48.01	48.37	45.48	46.14	45.51
Alumina	Al_2O_3	17.18	16.76	15.19	14.50	15.56	17.03	15.51
Ferric oxide	Fe_2O_3	4.09	4.36	3.61	5.52	4.25	4.18	4.55
Ferrous oxide	FeO	7.18	5.90	7.66	6.27	8.24	7.68	8.51
Magnesia	MgO	4.11	4.36	7.00	8.59	6.97	4.94	4.98
Lime	CaO	7.84	7.46	10.55	9.03	9.35	8.84	8.28
Soda	Na_2O	3.87	4.40	3.09	2.86	3.78	3.43	3.42
Potash	K_2O	1.85	2.05	1.49	1.10	1.40	1.44	1.48
Water lost above 105° C ..	H_2O+	0.33	0.70	0.29	0.62	0.39	1.27	1.47
Water lost below 105° C ..	H_2O-	0.74	0.79	0.42	1.00	0.59	0.98	0.92
Carbon di-oxide	CO_2	nil	nil	0.05	nil	0.10	0.10	0.58
Titanium di-oxide	TiO_2	1.56	1.93	2.22	1.84	2.94	3.04	3.68
Zirconia	ZrO_2	..	..	..	0.02	0.02	..	nil
Phosphorus pentoxide ..	P_2O_5	0.48	0.58	0.44	0.33	0.83	0.77	0.80
Sulphur	S	..	..	..	nil	nil	..	nil
Chromium tri-oxide	Cr_2O_3	..	..	..	0.05	0.03	..	nil
Manganese oxide	MnO	0.17	0.19	0.14	0.13	0.15	0.16	0.25
Nickel oxide	NiO	0.02	0.04	0.01	0.01	trace	0.01	0.02
Strontia	SrO	0.03	0.05	0.04	0.05	0.08	0.05	0.04
Baryta	BaO	..	0.05	0.03	0.04	0.05	0.05	0.04
Total		100.32	99.95	100.24	100.33	100.21	100.11	100.04

No. 1—Basalt—Sharp's Road, near quarry, Hoonhay Valley.
west flank, Lyttelton Volcano.
II." 5. 3. 4—Andose.
No. 2—Hornblende Basalt—Andrew's Quarry. Sumner Rd, Heathcote
II. 5. "3. 4—Andose.
No. 3—Basalt—Halswell Quarry.
"III. 5. 3. 4—Camptonose.
No. 4—Basalt—Diamond Harbour, Lyttelton.
III. 5. 3". 4—Camptonose.
No. 5—Basalt—Quail Island, Lyttelton.
"III. 5". 3. 4—Camptonose.
No. 6—Basalt—Stony Bay Road, height about 500m., Akaroa.
II (III). 5. 3". 4—Andose.
No. 7—Basalt—Duvauchelles Bay Road, near wharf, at sea level, Akaroa.
(II) III. 5. 3. 4—Camptonose.

All analyses by F. T. Seelye, Dominion Laboratory.

These analyses are those of basalts with a slightly higher percentage of soda than usual, and therefore it is not surprising that some of the rocks with a slightly lower percentage of silica are characterised by the presence of felspathoids in small quantity. This feature is more pronounced in the later flows, notably those from Quail Island. It might be mentioned here that hornblende bearing basalts do occur rarely as flows, but that no hypersthene has been noted by the author in any specimen from which sections have been made.

B.—Plutonic Rocks.

Syenite and Gabbro.

The only plutonic rocks present are those lying near the extremity of Onawe Peninsula in Akaroa Harbour. All the end of this striking landscape feature of the harbour consists of syenite, and lying along the northern side of the syenite is a gabbro, whose field relations to the syenite are not clear. On the western side of the Peninsula the contacts are completely masked by soil and slip material, and on the eastern side the exposures, though clearer, do not give any decided evidence. Whether the plutonic mass is part of an original land surface on which the volcanic cone was built, or whether it represents a deeper-lying portion of the same volcanic mass, which has now been exposed by denudation, is a matter which is quite doubtful. The syenite, as will be shown later, exhibits features which connect it in some ways with the trachyte dykes belonging to a later eruptive period, but it is certainly penetrated by trachyte dykes, and must therefore be older than some of them.

The macroscopic features of the syenite are as follows :—The rock is of a yellowish-brown colour, very vesicular in texture, and at times decidedly drusy with crystals of quartz up to 5 cm. in length and felspars frequently square in section lining the cavities. The rock is chiefly formed of felspar crystals, stained slightly with oxide of iron. Microscopically the rock is composed of a somewhat

even grained crystalline mass of felspar, quartz, and augite, with grains of dark coloured iron ores. The felspar consists of orthoclase and plagioclase, both kaolinised. The latter proves to be albite, judging by the extinction angles and refractive index. The quartz is usually interstitial, and does not occur in sufficient quantity for a granite, hence the name assigned. The F.M. mineral is of greenish brown colour, occasionally with a bluish tinge, and then again sap-green, at times with a bright green border. It is somewhat opaque, so that it is difficult to get a correct extinction angle, but where clearly seen it proves to be too high for an amphibole. The mineral is strongly pleochroic in the colours mentioned above, and is frequently stained dark with iron oxides. These properties make it almost certain that the mineralis an augite with an admixture of the aegerine or acmite molecule, the presence of a soda mineral is what might be reasonably expected from the chemical analysis given below. There is a little apatite, and a considerable quantity of an iron ore of black or brownish black colour, therefore a magnetite bearing some proportion of titanium.

The following analyses have been made of the rocks at this point, the first by the Dominion Laboratory, and the last two by Mr. R. O. Page :—

		1	2	3
Silica	SiO_2	60.76	41.54	48.05
Alumina	Al_2O_3	16.91	22.28	25.11
Ferric oxide	Fe_2O_3	6.88	3.35	2.64
Ferrous oxide	FeO	0.39	8.88	7.16
Magnesia	MgO	0.22	4.71	1.61
Lime	CaO	1.58	12.01	7.00
Soda	Na_2O	6.49	1.23	1.40
Potash	K_2O	3.71	2.05	3.72
Water lost above 105° C..	H_2O+	1.15	0.59	0.70
Water lost below 105° C..	H_2O--	0.88	0.68	1.25
Carbon di-oxide ..	CO_2	0.14	0.80	..
Titanium di-oxide ..	TiO_2	0.55	2.47	0.75
Phosphorus pentoxide ..	P_2O_5	0.10	..	..
Chromium tri-oxide ..	Cr_2O_3	..	..	..
Manganese oxide ..	MnO	0.14	..	0.40
Nickel oxide	NiO	trace	..	..
Strontia	SrO	nil	..	..
Baryta	BaO	0.01	..	..
Total ..		99.91	100.59	99.79

No. 1—Syenite—Onawe, Akaroa.
I (II). "5. (1) 2. 4—Larvikose.
No. 2—Gabbro—Onawe, Akaroa.
II. 5. 4. 2—No name assigned.
No. 3—Contact Rock—North of Gabbro, Onawe, Akaroa.
II. 5. 4. 1—No name assigned.

The gabbro appears in the hand specimen as a rock of varying grey to dark grey colour, some samples are almost white, and then again as the percentage of iron ores and F.M. minerals increases, it becomes quite dark in shade. The microscope shows it to be composed chiefly of labradorite with subordinate amounts of augite, magnetite, biotite, and olivine, with, in some cases, alteration products from these minerals, such as calcite, chlorite, and epidote. Determinations of the proportion of these present made with a Shand Micrometer show marked variations. In one slide from the rock, whose analysis is quoted on page 125, the following were obtained :—Felspar, 84 p.c. ; augite, .3 ; mica, 1.4 ; magnetite, 6.4 ; calcite, 2.4, and chlorite and epidote, 5.3 ; another slide from the same rock gave felspar, 53 ; augite, 31 ; mica, 2.2 ; magnetite, 13. A slide which showed considerable quantity of the dark constituents gave the following percentages :—Felspar, 44 ; augite, 6 ; magnetite, 43 ; and mica, 6 per cent. These figures give some idea of the variability of the rock.

The felspar, a somewhat basic labradorite, shows schiller inclusions, and sometimes an alteration to a sericitic mineral, the augite is diallagic, slightly pleochroic, and occasionally schillerised ; the olivine varies in amount, being rare in some slides, and frequent in others ; it is serpentinised along cracks, stained with iron oxides, and at times altered to carbonates ; the mica is a biotite strongly pleochroic in deep brown tints, usually in broad flakes, but sometimes as a border to the iron oxides. Hardly any slide is free from crystallised carbonate, and in one there is a distinct vein running through the section, while in another there were considerable areas composed wholly of this mineral, some of it certainly derived from the olivine, but more appears to have come from the felspar, which is, at times, freely altered to calcite along the cleavage planes or in irregular directions ; some fills cavities in the rock. In slides where alteration is marked both epidote and chlorite are present, the former in granules. Grains of magnetite are quite plentiful, often fringed with mica, and sometimes with a whitish substance (leucoxene ?), suggesting that the magnetite is titanium bearing, a conclusion borne out by the analysis ; there is also some secondary ilmenite or titaniferous magnetite in skeletal forms, and colourless isotropic mineral of high relief, with the form of rounded grains (lime garnet ?) The proportion of magnetite increases near the boundary of the outcrop, but this increase may be illusory, and there is no pronounced segregation on the margin of the mass.

The chemical analysis of a sample of the rock of the more leucocratic variety is given on page 125. It shows some well-marked peculiarities, and in view of these I had the result checked by the analyst, so that I have no doubt as to its accuracy. It will be found that this analysis cannot be assigned a place in the Washington-Iddings scheme of names, but it no doubt belongs to a species

related to a gabbro in which the felspar is in excess, that is to an anorthosite or labradorite rock. The low percentage of silica, and the high percentage of alumina may be explained in this way if allowance be made for the non-siliceous minerals of the rock ; the percentage of potash is accounted for by the presence of biotite. Titanium oxide is high, but this is borne out by the microscopical examination. In this connection it might be noted that the small beach close to the outcrop of gabbro on the western side of the peninsula contains a high percentage of magnetic iron sand, which has no doubt been furnished chiefly by the gabbro, although the syenite may have yielded its quota as well.

Neither the microscopical nor the chemical examination shows any decided connection between the syenite and the gabbro. Although samples were taken wherever possible in the gabbro across its outcrop till the syenite was encountered, there appeared to be no certain progressive change from gabbro to syenite, which might suggest that the rocks were derived from a common magma by differentiation. One rock has therefore in all probability been injected into the other, though which was the first I cannot say, in the light of such evidence as appeared to me, but the blood relationship of the syenite to the trachyte dykes is fairly obvious, and this may be the later, since the dykes belong to a late volcanic phase.

Immediately to the north of the gabbro exposed on the shore on both sides of the peninsula is a dark-coloured basic rock. On the east side a whitish rock apparently overlies this, and both are succeeded by tuff beds containing rhyolite pebbles. The dark coloured basic rock is compact in texture, and shows no minerals prominently. Under the microscope it appears of even grained texture, the constituents being labradorite, usually in the form of short laths, very numerous small flakes of a brown pleochroic mica, and augite, the last-named in grains of small size down to microlites. There are phenocrysts of labradorite, but these grade into the felspars of the groundmass. Numerous grains of an iron ore also occur, evidently an alteration product of some mineral like augite, the dark coloured grains forming aggregations associated with granular masses of unaltered augite, the whole having no decided form, and being, in all probability, foreigners to the rock. Several of these masses were noted in the slides examined. Although the great majority of the felspars in certain slides are distinctly labradorite, there are areas where the form of the mineral is more granular, and the felspars are untwinned. Some slides show a field made up almost entirely of such materials ; also some of the felspars have a lath-like form with straight extinction, others have a short, stumpy, almost granular shape, and all with a lower index of refraction than balsam, they are therefore probably orthoclase. The number of flakes of mica in this facies of the rock is much reduced from the other variety, but they occur in places frequently as a mantle

to the iron ores, which are extremely numerous, small grains of a greenish augite also occur as well as grains of quartz and occasional calcite. The general appearance of the rock suggests that it is a re-crystallisation of a pre-existing mass in all probability under the influence of the intrusive gabbro, and if this is correct it shows that the gabbro was later than some of the rocks forming the peninsula, and may represent material congealed in the throat of the volcano subsequently exposed by denudation, as has been suggested in other cases by Judd and Iddings. An objection to this depends on the fact that there is not the resemblance between the chemical composition of the gabbro and of the effusive basic volcanics that might be expected.

The chemical composition of the rock alongside the gabbro is given in analysis No. 3, and it shows certain peculiar features, some of which occur as well in the analysis of the gabbro. The low content of silica, and the high content of alumina, associated with an excess of the potash over the soda is somewhat remarkable. The high content of potash is no doubt attributable to the presence of the biotite in quantity, and perhaps in the process of re-crystallisation this has contributed to the formation of the orthoclase in certain parts of the rock, but the mineral which should account for the lime in the altered rock does not appear to be present. Evidently the rock is highly variable, and the case presents peculiarities which I cannot unravel with the evidence at my disposal.

This rock underlies a tuff containing numerous rhyolite pebbles, so it may belong to an earlier period in the volcanic history of Banks Peninsula than even the rhyolites of Gebbies Pass, in which indeed there is independent evidence of the existence of previous volcanic rocks. Of course, it is possible that this tuff may, after all, belong to the chief Akaroa eruption period, the fragments of rhyolite being included in the material torn from the underlying basement through which the volcano has forced its way.

C.—Dyke Rocks.

(i.) General Features and Analyses.

The minor intrusives of the area consist of dyke rocks belonging to the two centres of Lyttelton and Akaroa. The arrangement of the dykes is the same in each case. On the margins of the volcanic mass belonging to each focus they are disposed regularly with radial orientation, very few occurrences departing from this arrangement, but in the neighbourhood of the centre of each volcano they occur quite irregularly, and cross at all angles. In that part of Lyttelton Harbour to the south of Quail Island, and round the shores of Charteris Bay and the head of the Bay this irregular criss-cross is excellently shown, while a similar arrangement exists on Onawe Peninsula and on the eastern shore of Akaroa Harbour at Lushington Bay. Careful plotting of the dykes from both harbours shows

no order or law governing their orientation. They vary in size from mere ribbons 2 cm. or so in width up to masses 20 m. across, and in some of these latter cases they can be traced from the sea-shore of the central caldera right over the summit of the crater ring to the exposed fringe of the volcano. Sometimes, however, they are lens shaped, and thicken rapidly to peter out again in a few hundred metres.

The number of dykes appears to be greater in the case of Lyttelton than in that of Akaroa. Since Lyttelton is probably older than Akaroa, it has therefore suffered more from erosion, and so a greater percentage of the dykes are visible at the surface, the inability of some intrusions to force their way up through the overlying sheets of lava and fragmentary material, diminishing their chance of being exposed unless the covering beds are removed, so that the actual superiority in number attaching to Lyttelton may, after all, be delusive.

In both cases the dykes consist of trachytic, andesitic, and basaltic varieties, but the first-named outnumber the others in volume of intruded matter. There is a close association in character between the trachytes and andesites, and the two species pass into one another with well marked gradation; there is also a close resemblance between the analyses of the dykes from the two centres, as will be clear from a comparison of the analyses in the two lists given on pages 130 and 149. Of these analyses Nos. 1, 5 6, 7 and 9 of the Lyttelton series, and Nos. 1, 3 and 4 of the Akaroa series were made by Mr. Seelye of the Dominion Laboratory, and No. 2 of the first set, and No. 2 of the second set by Mr. R. O. Page, of the Woolston Tanneries Co., Christchurch. The most notable feature of both sets is, perhaps, the important percentage of soda which characterises all the rocks, so it is reasonable to expect that soda minerals will be strongly developed. In some of the trachytes there is a high percentage of silica, so high that in some cases the rocks might reasonably be called rhyolites, did they not possess trachytic characters, notably texture, rendering such a designation untenable. Nothing further need be said at this stage with regard to their features, and special reference will now be made to typical occurrences, the rocks from the two centres being taken in turn, those of Lyttelton first.

(ii.) LYTTELTON SYSTEM.

(*a*) Trachytes and Trachy-andesites.

The dykes with trachytic affinities will be dealt with first, and included with them will be certain of the related andesites. The order of consideration will be that of their occurrence round the circle of the volcano, the sector first selected being that between Sumner and Heathcote, which lies to the north and north-east of the town of Lyttelton.

ANALYSIS OF LYTTELTON DYKE ROCKS.

	1	2	3	4	5	6	7	8	9
Silica	65.21	68.52	71.29	70.04	53.54	54.85	58.43	48.60	46.98
Alumina	12.22	19.47	15.70	15.40	17.51	21.42	17.50	17.87	15.39
Ferric oxide ..	7.27	1.03	1.50	4.65	3.37	2.56	2.44	6.20	6.20
Ferrous oxide ..	0.22	0.29	0.30		5.39	2.17	4.72	5.76	5.57
Magnesia ..	0.68	0.32	0.89	0.55	2.33	1.63	1.78	4.32	3.17
Lime	1.02	1.16	3.41	trace	5.08	4.12	4.24	9.11	6.05
Soda	4.69	4.95	4.81	4.35	5.70	4.69	5.20	4.66	3.46
Potash.. ..	4.67	3.55	2.35	4.65	2.89	3.44	3.54	2.06	2.36
Water lost above 105° C	0.54	0.69	0.07	0.57	1.03	1.86	0.17	1.78	2.96
Water lost below 105° C	1.56	0.30			1.08	2.00	0.35		4.62
Carbon dioxide ..	nil	nil	..	..	nil	nil	0.12	..	nil
Titanium dioxide ..	1.14	.40	..	..	1.41	0.48	1.22	..	2.09
Zirconia	0.08	..	..	..	0.04	0.07	nil	..	nil
Phosphorus pentoxide ..	0.31	..	..	..	0.61	0.13	0.30	..	0.90
Sulphur	nil	..	..	..	trace	0.01	..	..	nil
Manganese oxide ..	0.05	..	trace	..	0.15	0.15	0.15	..	0.13
Nickel oxide	nil	..	..	..	trace	0.02	nil	..	trace
Strontia	nil	..	..	..	0.04	0.13	0.02	..	0.12
Baryta	0.07	..	..	..	0.07	0.06	0.05	..	0.09
Total	99.73	100.68	100.32	100.21	100.24	99.79	100.23	100.36	100.09

No. 1—Trachyte, Heathcote Valley, over Lyttelton Tunnel.
(I) II. 4. 1. 3″ Grorudose—Anal., F. T. Seelye
No. 2—Trachyte, south side Quail Island, Lyttelton Harbour.
I″. 4. (1) 2.″4 Lassenose—Anal., R. O. Page
No. 3—Tridymite-Trachyte, Lyttelton-Sumner Road.
I. 4. 2″. 4 Lassenose—Anal., P. Marshall
No. 4—Trachyte, Cass Peak, west side of Lyttelton Harbour.
I. 4. 1. 3″ Liparose—Anal., Chemistry Laboratory, Canterbury College
No. 5—Olivine Trachy-andesite, Evans Pass, Lyttelton-Sumner Road.
I (II). 5. (2) 3. ″4 Piedmontose—Anal., F. T. Seelye
No. 6—Olivine Trachy-andesite, summit of spur on west side Heathcote Valley.
II. 5. 2. 4 Akerose—Anal., F. T. Seelye
No. 7—Trachy-andesite, Hoon Hay Quarry, lower end.
″II. 5. 2. 4 Akerose—Anal. F. T. Seelye
No. 8—Dolerite, Dyer's Pass Road, Cashmere.
II. 6. 3. 4 Salemose—Anal., R. Speight
No. 9—Hornblende Basalt, Sumner, alongside road on south side of valley.
II. 5. 3. 4 Andose—Anal., F. T. Seelye

Nos. 4, 5 and 8 have been published before, and are included for the purposes of comparison.

A consideration of the series as a whole shows that the magma from which the dykes were derived was moderately alkaline in character.

Analysis No. 1 is of a trachyte occurring in the Port Hills immediately over the tunnel at the head of Heathcote Valley. It is the middle one of three which occur on the eastern slope of the valley, but as far as I could see was not cut by the Summit Track. It is thus somewhat lens-shaped, as so many of the trachyte dykes are. It has been quarried for building stone, and used in several buildings in Christchurch, such as the Magistrates' Court and portions of the Chemical Laboratory. In the hand specimen it is rough to the touch, vesicular in texture, brownish pink in colour, and shows an occasional small phenocryst of felspar.

Under the microscope the rock appears to be composed chiefly of felspar, with an occasional augite phenocryst and flecks of iron ore, including hematite, and in the groundmass numerous microlites of greenish augite. The phenocrysts are both sanidine and plagioclase, the latter with an extinction angle on either side of the twinning line up to a maximum of 9°, and the refractive index is higher than balsam. This shows the mineral to be an oligoclase-andesine. Many of the crystals show a marginal outgrowth with a denticulate border of more acid felspar. In the groundmass no felspar was observed with a higher index than balsam. There is a

good deal of albite in short stumpy laths, sanidine in laths, and in more quadratic shaped individuals, while there are numerous individuals with the denticulate margins and forked ends characteristic of anorthoclase. The F.M. mineral is an aegerine-augite, slightly pleochroic in green and brownish-green and with high extinction angle. The largest felspar phenocryst measured was 7.5 mm. in length, but this was quite exceptional, as their size is frequently not larger than the elements of the groundmass. The numerous microlites in this are no doubt referable to the same mineral species. These are in short, stumpy forms, green or brownish green in colour, very slightly pleochroic, with an extinction angle difficult to determine owing to the opacity of the mineral, but, in many cases, over 20°. Some of the laths look like flakes of mica, and some few of these are certainly present, but by far the larger number of the laths are not that mineral. The larger crystals of augite show at times a corrosion border, and it is likely that a considerable proportion of the iron ore occurring in the fabric of the rock has been derived from it originally. Needles of apatite are occasionally seen, especially included in the felspar phenocrysts.

The most interesting mineral, however, is tridymite, which occurs freely in places forming a part of the fabric of the groundmass, and also lining cavities ; some parts are free or comparatively free from it. The low index of refraction, the corresponding marked relief, the low and at times hardly discernible polarisation colours, and the tile-like arrangement of the aggregates are characters which leave no doubt as to its identification. In some places the felspar laths of the groundmass are included in the tridymite, which suggests that some of it may be of primary origin, though belonging to the last phase of the crystallisation. Occasionally it is arranged in stellate and radiating groups.

The chemical analysis of this rock is what might have been expected from its mineral content. The only surprising feature is the low percentage of alumina, which almost corresponds to that of a pantellerite, though the absence of anorthoclase from the phenocrysts would render it inadvisable to apply that name to the rock. The excess of silica in the calculated norm furnishes a striking coincidence with what actually occurs.

Alongside this dyke, lower down the slope, and cut by the Summit Track just east of the point where the Bridle Path crosses the ridge is another trachyte, which has been referred to by Kolenko (loc. cit., pp. 126-27, by Filhol (loc. cit., pp. 114-5), and by Hutton (loc. cit., pp. 126-7), and probably by Ulrich (loc. cit., p. 147). This shows a resemblance to the former rock, but with some differences. The analyses cited by the second authority, allowing for the discrepancies in connection with the alkalies, show the rock is of a distinctly alkaline type. Its microscopical characters are as follows :—In a holocrystalline groundmass there are occasional

phenocrysts of felspar, up to 5 mm. in length, all with lower index than balsam; both sanidine and albite showed in the slides I examined, the former in occasional carlsbad twins, also individuals with the water mark and fine cross hatching of anorthoclase. There are very occasional large phenocrysts of brownish hornblende, and a few larger crystals of aegerine-augite, and also in the groundmass very numerous smaller, short, stumpy forms of the latter mineral, greenish in colour.

The felspar of the groundmass shows two distinct habits, both with lower index of refraction than balsam, one habit being usually restricted to a defined area in the slide, although a patch of one type may be included as an island in the other. Perhaps the more numerous are shortish quadrangular individuals, untwinned, some with the denticulate margins and forked ends of anorthoclase. The other form is in uniformly long narrow laths, arranged in flow lines or more commonly in sheaf-like aggregations. These show extinction angles ranging from 0° to 12°, and are therefore albite. Small flakes of a brown pleochroic mica, and needles of apatite also occur, included in the felspar and also in the groundmass, and there are numerous grains of iron ore, some derived no doubt from the augite. There is a stain of chloritic material in some parts of the slide. No tridymite was observed. Treatment of the slide with hydrochloric acid and subsequent staining showed the presence of gelatinous silica, although no undoubted nepheline was detected. It no doubt occurs in the mesh between the felspar laths, and the rock is therefore a trachytoid phonolite. It is greenish grey in the hand specimen, sometimes with a lustre reminiscent of that of a mica schist. At times it is compact and without this lustre.

I think this must be the same rock referred to by Ulrich as a trachytoid phonolite, with analysis by Butement (3rd Rep. Austr. Assoc. Adv. Sci., 1891, p. 147, footnote). After careful consideration I have come to the conclusion that this corresponds to the dyke described by Haast (loc. cit., pp. 334-5), an analysis of which is given on page 330, as well as under the number 29A of the tunnel series. This number is missing from the set in the Canterbury Museum, but 29B occurs, and I have no doubt that this rock, though very slightly greenish in colour, represents a facies of the greenish grey rock referred to by Ulrich. The specimen does not warrant the adjective " compact " as a description, but it may be a marginal facies of the rock as it occurs in the dyke. I had thought the rock referred to by Ulrich was the massive dyke on the western side of the valley, but have concluded that this supposition is incorrect, and that the dyke to the west is another occurrence of the trachytoid phonolite, which will be dealt with later.

A similar greenish grey rock occurs as a dyke on the Lyttelton Sumner Road, almost parallel with the road above Gollan's Bay. It has been quarried in several places along its line. Under the

microscope it appears to be somewhat similar in appearance to the rock just described, the felspars and the groundmass is similar, but instead of the phenocrysts of augite there are larger crystals of a brownish hornblende. There may be a little mica as well present in the groundmass, but there is certainly a fair amount of hornblende in addition to the greenish augite.

The groundmass consists of felspar laths of the long type, as well as a much greater proportion of felspars of the shorter type mentioned in connection with the last slide, both having a lower index of refraction than balsam. The phenocrysts, however, are varied in their behaviour. The larger number both of the twinned and untwinned varieties of felspar have a refractive index less than that of balsam, so that alkaline felspar is certainly present, and a small number of these are anorthoclase. A fair number of felspars have also a higher index of refraction, with an extinction angle (Michel Lévy) ranging as high as 14°, so they must be oligoclase-andesine; these occasionally show twinning according to the pericline law. A small amount of tridymite occurs in cavities, as well as a mineral with the brownish stain fringing the larger cavities, and sometimes filling them up; this may be a zeolite of some description or tridymite, which has been stained brown by iron oxide. Needles of apatite also occur.

I think, though I cannot be certain, that this is the rock referred to by Marshall (Loc. cit., pp. 384-5) as a phonolitic trachyte. He gives an analysis which corresponds quite well with that of some of the more basic varieties of this rock species met with in the locality. The percentage of soda in this analysis is quite in keeping with the analysis of other trachyte dykes. This is, in all probability, the rock referred to by Hutton as a hornblende trachyte (loc. cit., pp. 125-6).

More closely resembling the second dyke from Heathcote Valley is a dyke penetrating Marshall's tridymite-trachyte close to the point where it is cut by the Sumner Road. This shows the flow lines and sheaf-like arrangement of the laths of the groundmass, and the greenish augite occurring both as phenocrysts and microlites. Anorthoclase is among the phenocrysts.

Analysis No. 3 is that of the tridymite trachyte rock, described by Marshall (loc. cit., p. 379); it is inserted for the purpose of comparison, since it shows some of the features which belong to the more acid phase of these trachyte dykes as well as certain features belonging to the more basic variety, and which are exemplified in the next dyke to be considered. It will be noted that Marshall considered whether the name dacite should be applied to the rock, although he finally assigned it to the trachytes.

Analysis No. 7 is of a specimen from a dyke 5 m. wide, which is met with on the very top of Evans Pass on the road between Lyttelton and Sumner. The rock varies somewhat in colour; it

is usually a grey, whitish at times, and then again brownish, especially when the iron in it is oxidised. It is somewhat vesicular, and shows steam holes of considerable dimensions. Felspar phenocrysts occur, but the most remarkable visible content is the hornblende. This forms longish crystals, up to 10 cm. in length, and occasional nests, which are apparently crystals in process of resorption, these nests may have a diameter of 75 mm. or more.

Under the microscope the relations to the normal trachytes are clearly shown, though the rock might be classed as an andesite, as it was indeed called by Hutton (loc. cit., pp. 134-5). The slide shows the rock composed of a holocrystalline groundmass, in which there are phenocrysts, felspar, hornblende, and augite. The felspar phenocrysts are almost entirely of a species with a higher index of refraction than balsam, and an extinction angle (Michel Levy) as high as 27°, therefore it is an andesine-labradorite. There is a little untwinned felspar, some with a lower index than balsam, and therefore, in all probability, sanidine. The phenocrysts go up to 6 mm. in length, and many are bordered with untwinned felspar of lower refractive index, with at times jagged boundaries to the crystals. The hornblende is brown in colour, strongly pleochroic, and partially resorbed, the border being of iron ore and a greenish mineral, probably aegerine-augite. The augite is greenish, some of it violet-coloured, slightly pleochroic, with high extinction angle and occasional diallagic structure. The groundmass is composed of short stumpy laths of felspar and greenish augite, the latter, however, frequently showing a brown tinge. The texture is distinctly trachytic. The felspar laths have invariably a lower index of refraction than balsam. The majority are twinned, and have an extinction angle up to 12°, and are therefore an albite or an albite-oligoclase, but there are a considerable number untwinned, and showing straight extinction, so sanidine is almost certainly present. There are numerous grains of iron ore, and occasional small flecks of biotite, and apatite needles included in the felspar and the groundmass. Some of the felspars include greenish microlites with oblique extinction, which are no doubt augites. Much tridymite occurs in places, also chacedony exhibiting agate banding in cavities. There is also a small amount of olivine in grains, bordered and replaced partially or wholly by iron ores. Occasional zircons also occur, and a mineral with idiomorphic outlines, straight extinction, higher index of refraction than augite, marked relief, colourless, somewhat dull polarisation colours. But for the last character I should conclude it was zircon. The individuals occur in the ground mass, and also in the augite and hornblende.

The rock thus shows a connection with the trachytes in mineralogical characters, although the nature of the felspars and the presence of olivine indicates a relationship to a more basic rock as indeed does the chemical analysis. It seems appropriate, therefore, to call it an olivine trachy-andesite.

When considering such a rock, an interesting comparison may be made with a series from Mount Macedon, Victoria, described by Skeats and Summers (Bull. Geol. Survey of Victoria, No. 24, The Geology and Petrology of the Macedon District, 1912). In that locality there is an anorthoclase trachyte with similar chemical composition to those under consideration, and also associated with them an olivine anorthoclase trachyte, the large amount of olivine explaining the higher percentage of these rocks in magnesia over the Lyttelton occurrence.

A closely related dyke to the one on Evans Pass occurs in the quarry just west of the tridymite-trachyte occurrence close to the road. This dyke is about 3 m. wide, is oriented towards Quail Island, and has been followed along in order to make an access to the quarry. The rock is slightly browner than the one just referred to, and there is slightly more olivine, and more iron-oxide, and a considerable amount of calcite filling cavities.

This series of dykes from the sector extending from Heathcote Valley to Evans Pass rather emphasises the importance of the trachytic facies, but it must be remembered that basic dykes are to be found, though sparingly. There is the prominent basaltic dyke behind the hotel at Sumner, as well as others around the base of the hills between Sumner and Heathcote, others, too, are exposed on the Summit track. In the outer fringe of this part of the region, basalts appear to be more important. This, no doubt, results from the basalts being more fluid and more able to penetrate into the outlying portions of the volcano, while the trachytes, being more viscid were rather restricted to the belt nearer its heart.

The varied character of the rock from a particular dyke is exemplified in the case of the massive intrusion on the ridge on the west side of Heathcote Valley, which forms such a striking feature as viewed from the Heathcote Railway Station. In the hand specimen the rock is usually a dark grey colour, with few felspars showing, the fracture in nearly all cases having a peculiar glistening surface, due in part to the cleavage of the felspars, which are arranged in sub-parallel lines. The rock, however, shows several modifications even in the hand specimen. It is at times coarser in texture, and then again finer, and on the extreme margin of the dyke it has a tinguaitic habit, being dark green in colour, compact, and with the peculiar fracture that characterises all the tinguaites I have seen.

Under the microscope the variation is more strongly marked, There is a trachyte facies, whose most striking feature is the comparative scarceness of the felspar phenocrysts ; these are exclusively of sanidine, frequently in carlsbad twins. The only other phenocryst present is aegerine augite, in short stumpy crystals greenish in colour, and slightly pleochroic, much the same as in the other trachyte dykes. The groundmass is very fine in some cases, coarser

in others. When fine it consists of a felt of microlites of felspar and of greenish-blue augite. The former have straight extinction as a rule, though in some it inclined ; all have a lower index of refraction than balsam, so the former are no doubt sandine, and the latter albite or albite-oligoclase. There is much magnetite in the form of small grains.

Owing to the marked phonolitic appearance of the rock, it was carefully scrutinised to see if any nepheline or other felspathoid were present, but these were not recognised for certain, though some small crystals with squarish section might be nepheline. When the slide was etched and stained it responded readily, showing the presence of nepheline or other felspathoid, but only as grains in the felspar mesh. This facies of the rock is, therefore, a trachytoid phonolite.

The facies with tinguaitic appearance occurs only on the margin where the fuid rock was chilled on intrusion. In the hand specimen the rock is very dense, compact and tough, with colour-like typical tinguaites. In the slides I have the rock does not show a typical tinguatic appearance, and when I showed them to Professor Iddings he doubted if it were a true tinguaite, but merely a compact variety of the phonolite. A slide kindly lent me by Mr. Bartrum, of Auckland University College, shows a much closer resemblance. When I tried staining tests the response was decided.

Some slides of this rock show the augite accumulated into definite patches or knots, which have at times a skeletal arrangement, the colour being green or greenish-blue and distinctly pleochroic. In some cases the patches are clouded over with alteration products, especially when the augite falls in size to microlitic dimensions. The felspars of the groundmass rarely exhibit lath forms, but show an indented mossy boundary, almost micrographic in appearance, with at times a suggestion of spherulitic arrangement. This form of felspar is untwinned.

However, the extreme variability of the rock was not entirely recognised until specimens were submitted for analysis. Slides from the samples sent showed a rock of different though related character, a result which is entirely borne out by the analysis, No. 6, on page 130. This shows a rock of moderately high soda content, too high magnesia and lime for a trachyte, the two last percentages no doubt due to the presence of augite and olivine, a conjunction which occurs elsewhere in the rocks of the area. The calculated norm shows 2.56 per cent. of nepheline. An interesting analogous analysis of a rock from Réunion Island is cited by Lacroix (Comptes Rendus, vol. 105, p. 541, 1912), the correspondence between the two being remarkable in every particular. I have not his description of the rock, but its name—Olivine trachy-andesite, answers precisely for the rock under consideration.

The felspar phenocrysts is this case are chiefly labradorite, but many have the denticulate margin of a more sodic species, instances occur where the centre of the crystal has a higher index of refraction than balsam, and the margin with a lower. In some cases the inner margin of the outgrowth is marked by a zone of microlitic inclusions, chiefly augite analogous to the margins of anorthoclase, these augite microlites being similar to those of the groundmass. There is some untwinned felspar occurring as phenocrysts, but it always shows a higher index than balsam, and is, therefore, in all probability an untwinned labradorite. The augite phenocrysts are at times beautifully idiomorphic, they are slightly green, occasionally purplish, in tint, and faintly pleochroic. The augite of the groundmass is in stumpy prisms or rounded grains, occasionally decidedly green, but frequently brownish in colour. The olivine occurs freely as grains up to 1.25 mm. in diameter. There are also aggregations of iron ores in granular form, which are the resorbed ghosts of former hornblende crystals. The groundmass is chiefly of felspar, at times with definite trachytic texture with fluidal arrangement, but in some places with a more orthophyric texture. By far the greater portion, if not the whole, of this felspar is of lower index than balsam, and consists of albite or albite-oligoclase, with an admixture of sanidine, as indicated by a fair proportion of untwinned forms having straight extinction. Some of the former show denticulate outgrowths, which may indicate the presence of anorthoclase. Although a small percentage of nepheline was present in the norm, this mineral was not detected for certain, though some small squarish grains in between the mesh of felspar prismoids, with low polarisation colours. may be this mineral. Staining tests were also inconclusive. Apatite needles occur freely in places. The chief element of the groundmass, however, after the felspar, consists of grains of augite, some of a faint green, others of a brownish tint.

The presence of a trachytic groundmass, with phenocrysts of labradorite, augite and olivine, and the chemical analysis suggest the most appropriate designation for this phase of the dyke to be an olivine trachy-andesite. There is, however, a decided relationship to the other facies occurring in the dyke.

Further along the crest of the ridge to the west at the head of Rapaki is a very massive dyke, 15 m. across, and forming a great wall 20 m. in height for a distance of some 200 m. It can be traced down the hill for a considerable distance in either direction, where it thins out and shows the characteristic lens form of the trachyte dykes. This rock has been quarried for building stone, and the United Service Hotel and Whitcombe and Tombs' building in Christchurch are among those constructed of it. The stone in the quarry breaks up naturally into quadrangular blocks, 1 m. to 1.25 m. square. It is somewhat rough in texture, and looks soft, but it is not so in reality, and stands the weather uncommonly well. In the hand

specimen it is yellowish-brown in colour, and appears almost entirely composed of felspar, with concentrations of iron-oxide along more or less spheroidal surfaces.

Under the microscope the groundmass appears to be composed of sanidine and albite-oligoclase, all the felspars showing a lower index than balsam. They are generally in the form of short stumpy laths of quadrangular forms, with the flow lines little developed. Greenish augite microlites also occur freely, in places altered to iron-ore brown in colour, but there appears to be a fair quantity of original magnetite. The phenocrysts are of felspar, both sanidine and plagioclase, with extinction angle up to 15°, and a higher index than balsam, therefore an oligoclase-andesine; also greenish slightly pleochroic augite occurs very sparingly. Tridymite shows freely in some slides, lining and filling the cavities. Hutton called this rock an andesite (loc., cit., p. 134), largely owing to the occurrence of the plagioclase, but it is related closely to the trachytes, and, in my opinion, should be called by that name.

On the next spur further west there is a somewhat interesting type recalling, in some respects, the trachy-andesitic dyke on the summit of Evans Pass. It is greenish-grey in colour, with hornblende phenocrysts up to 5 cm. in length. Under the microscope the amount of hornblende present appears to be greater than any rock in the region that I have come across. It is of the greenish-brown type, and grades down in size to individuals of almost microlitic dimensions. There are very occasional phenocrysts of greenish-augite, olivine, and of felspar, the last-named twinned and untwinned, but all with a higher index of refraction than balsam. The extinction angle belongs to an oligoclase-andesine. The groundmass is holocrystalline, and coarser in texture than the ordinary trachytes, it consists of greenish augites, small elements of hornblende similar to the phenocrysts, and grading up into them; also felspars of two distinct habits, or one in long laths, twinned, often in sheaf-like aggregations, and with extinction angles of oligoclase-andesine, and the other quadratic in form, frequently rhombic in cross section, often untwinned or with wavy extinction, but invariably with higher index than balsam. There is a good deal of black iron ore in the slide in the form of grains and disseminated dust, the former, in many cases, a resorption product after hornblende, since many of the smaller individuals of this mineral show chemical corrosion.

The rock would therefore appear to be an andesite, but with distinct relations to the trachytes, as is the case in other occurrences of the area.

Analysis No. 7 is of a rock which forms a dyke on the east side of the Hoon Hay Valley. It is about 4 m. in width, and can be traced right up the spur leading to Marley's Hill, and on to the slope facing the harbour. It has been quarried in several places for

building purposes, and the stone was used freely in Christchurch, the Cathedral, Bank of New Zealand, and other buildings being constructed of it. At the present time it is being quarried in the Hoon Hay Valley for stone for the Memorial Hall at Christ's College.

The stone is pale grey in colour, with no tinge of green, and with phenocrysts of felspar, hornblende, augite and olivine plainly visible. The felspars are up to 3 cm. in length, and the hornblendes 2 cm., the augites and olivines being smaller. The hornblendes sometimes form nests of crystals.

Under the microscope the rock is shown to be composed of phenocrysts, as mentioned above, in a holocrystalline groundmass. Both twinned and untwinned felspars occur, both with a higher index than balsam, though some of the latter are lower, the former with a maximum extinction angle of 30°, therefore it is an acid labradorite ; this conclusion is confirmed by a study of the cleavage flakes. Twinning on the albite and pericline laws was observed ; some of the untwinned forms are probably of the same species of felspar. Neither the augite or hornblende phenocrysts are common ; the former occur in granular forms with hardly recognisable pleochroism, and are not distinctly greenish in colour, as is usually the case with the aegerine-augite type common in the trachytes. The hornblende is scarce in the micro-sections, though it is a conspicuous constituent of the hand specimens. The olivine is in rounded grains, cracked, with high polarisation colours, and frequently replaced by iron ores (Iddingsite). The groundmass is coarse in texture, with indefinite flow structure. The felspars, of which it is composed, exhibit two distinct outlines (*i.*) short stumpy laths, and (*ii.*) sections more quadratic in form. All have an index of refraction lower than balsam. The plagioclases have an extinction angle up to 16°, a low index of refraction, and are therefore albite. The untwinned forms exhibit straight extinction, and are therefore sanidine. A little tridymite occurs in cavities.

There are occasional phenocrysts of felspar, untwinned, with lower index of refraction than balsam, denticulate margins, and with an alteration zone parallel to the margin, but with a clear zone outside it, and also with the wave-mark extinction of anorthoclase. It is the presence of these felspars and the aegerine augite, which shows that the rock has a genetic connection with the phonolitic trachytes mentioned previously, and this is well brought out in the analysis, in which the alkalies are high. The general characters show that the rock is intermediate between the andesites, and the somewhat alkaline trachytes, that is, it is related to the ciminites described by Washington (Journal of Geology, vol. 4, 1896, pp. 541-66, and 826-49), although it has not got the high percentage of potash of the Italian Rocks. The silica, alumina, iron oxide, and lime have percentages belonging to andesites rather than trachytes, but the percentage of akalies belongs to a trachyte ; the magnesia

present in the analysis being largely due to the presence of olivine. Considering the difference in the proportions of soda to potash, as compared with that of ciminites, it hardly seems proper to use that name, and the term olivine trachy-andesite is, therefore, more appropriately applied to the rock.

On the west side of the Hoon Hay Valley there is a similar dyke of trachytic affinities containing a little olivine. All the phenocrysts have a higher index of refraction than balsam, while the groundmass consists of sanidine and albite.

Further west there are trachyte dykes of interesting character. One was described by the present author under the name of a soda-amphibole trachyte (Trans. N.Z. Inst., vol. 40, 1908, p. 176). The identification of the F.M. mineral now seems to me to be doubtful, and that instead of it being a hornblende it is an augite closely related to the aegerine-augite of the ordinary trachytes of the locality. This rock has an abnormally high percentage of silica for a trachyte, but the excess of uncombined silica exists as quartz grains in the groundmass, and not as tridymite. Its texture and general properties show it to be a trachyte, and not a rhyolite, although the norm, calculated on the analysis as given shows it to be liparose in character.

There are other occurrences of rock of similar type besides that described at Cass's Peak, notably near Victoria Park between the tea house and the road, where it has been quarried, also on the Summit Track between Dyer's Pass and Kennedy's Bush, where the rock can be readily recognised by its peculiar greenish grey colour.

On the shore alongside the road at Governor's Bay there are two occurrences worth noting. One of these is a form with a glassy groundmass from a very narrow dyke. In the hand specimen this rock has a resinous pitch-stone-like appearance, and, under the microscope, the base is quite glassy, and contains phenocrysts of felspar, both sanidine and plagioclase and augite. The glass is brownish in colour, and quite dark under crossed nicols. It is full of greenish microlites of aegerine-augite, which are at times single narrow laths, again arranged in stellate or forked groups, and sometimes crossed at an angle, which may be either right or acute. The felspars are chiefly untwinned forms with lower index than balsam, but some of the individuals with this low index exhibit the cross twinning of anorthoclase.

There is a minor proportion of plagioclase with higher index than balsam, and extinction angle corresponding to an oligoclase andesine. Both varieties of felspar are quite clear and unaltered, but with cracks filled with some brilliantly polarising material resembling sericite ; they contain also grains of brilliantly polarising zircon as well as some isotropic mineral in very small grains with high relief. The augite is brownish-green in colour, and very slightly pleochroic. Magnetite occurs in grains frequently associated

with the augite. There is also a fair amount of titanite in grains, showing signs of alteration to a cloudy material (leucoxene), as well as needles and short stumpy columnar crystals of apatite. The rock is no doubt a form of the trachyte with glassy groundmass.

A little past this on the road towards the head of the Bay is a dyke forming the face of the sea-cliff, which has always attracted attention from its remarkable spheroidal weathering. The rock is jointed into quadrangular blocks, and what little oxide it contains has collected on the outside of spheroids or ellipsoids so that rudely circular or elliptical sections of them stand out on the exposed surfaces of the cliff. The remaining portion of the rock is creamy white or pinkish white in colour. It has a rough trachytic feel. Under the microscope it appears to be almost entirely formed of felspar ; the phenocrysts being of sanidine, with very little plagioclase, and the groundmass of sanidine in short stumpy laths, and in individuals with irregular boundary ; also some plagioclase with small extinction angle ; the groundmass contains a considerable quantity of quartz, so that the rock belongs to the more acidic facies of the trachyte. No tridymite was observed in the rock, the uncombined silica being entirely in the form of quartz.

Continuing round the periphery of the harbour it is found that trachyte dykes occur penetrating the rhyolites and greywackes in the vicinity of Teddington, Gebbie's Pass and Charteris Bay, but these present no noteworthy differences from the types mentioned previously ; they are usually, however, of the white leucocratic facies. Basic dykes also occur in the locality in the greywackes, and may be older than the present series, but the evidence of their minimum age is inconclusive. One of them occurs in the greywacke ridge to the west of the pass, and another on the very crest of McQueen's Pass, east of Gebbie's Pass, where the stones from the dyke were used by the Maories to construct one of their cooking ovens, this pass being right on the line of their usual route from the head of Lyttelton Harbour to their fishing grounds and game preserves on Lake Ellesmere.

Two very fine dykes occur standing out like walls at the head of Teddington Valley near the Kaituna Saddle, and others occur near the Rest House on the saddle. The two large dykes are oriented to Quail Island, and stand out in places to a height of 20 m. with a similar width. They are whitish in colour. One of them has a groundmass composed of sanidines, with a short stumpy lath or quadratic form, coarse in texture, with numerous small greenish-brown, slightly pleochroic microlites of augite and grains of derived iron ore, in which are phenocrysts of sanidine. The other is different in character. The phenocrysts consist of sanidine and a felspar with higher index than balsam and extinction angle of andesine, rounded grains of slightly greenish augite, small hornblendes partially or wholly resorbed, from which are derived the

masses or iron ores which stain the slide in places, all in a groundmass of low index or refraction composed of both orthoclase and plagioclase.

There are no dykes in the flows from Mt. Herbert, but the series is resumed on the east side of Purau Valley on the western slopes of Mt. Evans, in this case, too, with the orientation towards Quail Island.

Analysis No. 2 is that of the rock from a dyke forming a great curly mass on the south shore of Quail Island, and sending tongue-like apophyses into the neighbouring rocks. It is white or creamy-white in colour, but with coatings of iron-oxide on the joint planes. No F.M. minerals are visible to the naked eye or with the aid of a hand-lens.

Under the microscope the rock proves to be composed almost entirely of felspar, the only other constituent being flecks of iron ore, some of which has been derived from a brown pleochroic mineral, probably hornblende, though the parent mineral may be augite. Phenocrysts of sanidine, albite, and, perhaps, anorthoclase. occur sparingly in a holocrystalline groundmass. These phenocrysts show at times an alteration to a sericitic material. The felspar of the groundmass forms short laths, with a length approximately three times their breadth, and associated with these are individuals of shorter length and more quadratic cross section. There is a fair proportion of albite in the base, and numerous other crystals with the characters of anorthoclase. There are also untwinned felspars which are probably sanidine. This association of felspars is what might have been expected from the analysis. A small amount of interstitial quartz occurs in the slide. The rock is a trachyte with bostonitic affinities.

This type of rock is very common among the dykes near Quail Island. Variations in texture certainly occur, and variations in the number of phenocrysts and in the amount of iron are scattered through the rock, and concentrated on the joint planes. In some cases this forms quite an important constituent, derived, in all probability, from flecks of iron-bearing augite. These dykes are marked by their brown colour. In one case there were crystals of brown hornblende, but this rock was found in the tuff on the north side of Quail Island, and may not belong originally to that locality. In many cases the alteration of the felspar of the base has proceeded rather far, and the rock then somewhat resembles a keratophyre under the microscope.

This occurrence of rocks with bostonitic affinities is not solitary in New Zealand, since Marshall has described them from Portobello, Dunedin (Quart. Journ. Geol. Soc., vol. 52, 1906, p.p. 399-400).

Such a rock as this—practically composed of felspar—as well as others to be recorded from Onawe Peninsula in the Akaroa area, may prove to be a possible source of felspar for insulators and other

high-grade porcelains. Certainly its melting point may be slightly lower than if the mixture were pure potash felspar, but mixtures of soda and potash felspars are freely used for this purpose, and, after all, a good many of the so-called potash felspars show, when analysed, a tolerably large amount of the soda molecule.

(*b*) Basalts.

Attention has been drawn to the dykes of trachytic affinity, but there are others which are decidedly basic, and between the two some with double affinity. Mention has been made of the andesites of trachytic relationship containing olivine, but others occur whose basic character is more pronounced. One of the most interesting of these has been referred to by Bartrum (Trans. N.Z. Inst., vol. 49, 1917, p. 418), the description evidently made from a hand specimen. This rock occurs as a dyke on the southern side of the Sumner Valley alongside the road just west of the township. It is whitish or greenish-grey in colour in the hand specimen, with prominent hornblende showing freely, and numerous amygdaloids. Microscopically it has the following character. The groundmass is composed of long laths of albite, and, perhaps, sanidine, the former much predominating, with no felspar present showing a higher index than balsam. Associated with these felspars there is a considerable quantity of green augite microlites and grains of magnetite. The larger augites have a distinct violet tinge. There are numerous olivines in granular form, and occasionally in idiomorphic crystals, up to 1.5 mm. in diameter ; at times the mineral is fresh, and then again completely stained with iron oxide (? Iddingsite). Hornblendes, brown in colour, with a slight tinge of green, and unresorbed, are also frequent, but the most remarkable constituent is tridymite. This occurs as a part of the fabric of the groundmass, and also filling cavities ; in some slides it is absent. There is so much of this material present that it would be regarded as an abnormality were not the mineral present somewhat freely in other cases, but its association with a rock of otherwise basic affinities appears somewhat remarkable. Although felspar phenocrysts are quite occasional, the fresh nature and generally unaltered character of the minerals, rather militates against it being considered as an alteration product from felspars, which were once there ; it is probably a primary constituent.

The analysis No. 8 of the series shows a slightly high percentage of soda for a basalt ; this conforms to the mineralogical character of the rock. The norm also shows 2.70 per cent. of silica, a conclusion borne out by the presence of tridymite.

Analysis No. 8 is that of a rock from Dyer's Pass described by myself in 1893. The calculated norm of this analysis contains quite an appreciable quantity of nepheline. A microscopical re-examination of the rock with much greater selection of slides, in order to see

if this might be accounted for in any way shows, that there is present a quantity of isotropic material, filling cavities, and also as patches in the groundmass of lower index than balsam, and showing signs of alteration by the development of dark rounded inclusions. This responds to staining tests, and there are also certain small crystals, squarish in section, also coloured by the stain, and with a slightly higher index than balsam. The isotropic mineral answers to most of the properties of analcite, and the small grains to nepheline, so it seems probable that both are present, the former derived as a secondary mineral from the latter. The analcite-looking mineral may, after all, be a glass, though this is not likely.

Analcite-bearing rocks have recently been discovered in the High Peak area of the Malvern Hills by Mr. J. F. D. White (personal communication).

Alongside this dyke, a few chains to the east is a hornblende-bearing basalt, quite different from that at Sumner, and showing clear relations to the dolerite just referred to. The hornblende is of the basaltic variety, and markedly resorbed, and there is present a similar isotropic mineral to that in the dolerite, in addition to the other minerals characteristic of basalts, viz., labradorite, olivine, augite, and magnetite. The isotropic mineral contains microlitic inclusions, and may be a glass, but the similarity of its properties to those of the neighbouring rock renders it extremely probable that it is analcite.

Further, there is a related occurrence in a massive basaltic dyke, which leads down the spur from Cooper's Knob towards Col. Heaton Rhodes' house at Tai Tapu. This is the most massive basaltic intrusion in the whole area. The rock is coarse-grained with phenocrysts of augite, olivine, and labradorite in a ground of felspar laths—some twinned and others untwinned, but all with a higher index than balsam—augite and magnetite grains, and also other grains which are occasionally quadratic, but sometimes anhedral of a clear isotropic substance with lower index than balsam.

A dyke, not so basic, occurs near Burns' Jetty on the Christchurch-Sumner Road. There is brown resorbed hornblende, much olivine replaced by iron ores, greenish augite, in a groundmass composed chiefly of similar augite and andesine laths, the latter in trachytic arrangement ; there is also an isotropic mineral in the groundmass and lining cavities, of lower index than balsam, and containing microlites of green augite and rounded dark coloured isotropic inclusions.

Some basalts exhibit a pronounced basic character, augite and olivine, phenocrysts exceeding the felspars in number. Specially noteworthy occurrences are the basic dykes in Andrews' Quarry near Heathcote Bridge, and that shown on the cliff behind the hotel at Sumner. Felspar phenocrysts are almost entirely absent in the

latter case ; the olivines show at times beautifully idiomorphic outlines, and very little staining with iron oxide ; and there are occasional crystals of partially resorbed basaltic hornblende, as well as an isotropic substance bordering and partially refilling the steam vesicles.

The narrower dykes usually show fine grained texture, and few phenocrysts, the groundmass being a glass in which there are very small individuals of augite and clouds of minute grains of magnetite.

The felspars in some of these basic dykes, specially those where phenocrysts are scarce are of a slightly more acid variety, being an acid-labradorite. They at times exhibit a sub-parallel orientation with grains of augite and olivine, and occasionally glass in between the felspar prismoids.

(iii.) AKAROA.

(*a*) Trachytes.

The dykes of the Akaroa system are similar to those of Lyttelton with the limitation as to number mentioned above. No dykes were recorded by the author at any part of the summit of the caldera although this has been traversed from end to end, some sections repeatedly, and the covering of soil on both internal and external slopes so masks the surface that good exposures are rare. For these reasons all the specimens referred to in the following descriptions were obtained from near sea level ; they are chiefly from the following localities :—Beach Road, Akaroa ; Lushington Bay ; Wainui Island ; and, above all, from the vicinity of Onawe, where the dykes are extremely numerous, intersecting that Peninsula in all directions, and occurring not only in the syenite and gabbro, but also in the lava flows and clastics, out of which the lowest beds of the great cone were constructed.

Analysis No. 1 (p. 149) is from that of a specimen taken from a dyke exposed in the cutting and on the shore between tide marks on the Beach Road just past the Boatsheds at Akaroa. The dyke is three metres in width, and is oriented to Onawe ; it occurs penetrating decomposed basaltic ash beds and lava flows. In colour the rock is a beautiful shade of pink, through which occasional felspar phenocrysts show. Microscopically it appears almost entirely composed of groundmass, the very sparing phenocrysts being sanidine and anorthoclase. No phenocryst has a higher index of refraction than balsam, and the same is true of those in the groundmass. This is of fine grained texture, and shows two types of felspar to be present. The first, which is, perhaps, the least numerous, shows a long lath shaped form, is polysynthetically twinned, and has an extinction angle corresponding to albite. The laths frequently show sheaf-like aggregations, and at times a well-defined flow structure. The second type of felspar is in short, stumpy,

sometimes quadrangular forms, with denticulated margins, and must be sanidine or anorthoclase, probably the latter. There is a considerable quantity of iron ore in the groundmass, the bulk derived from small laths of aegerine-augite ; a little quartz is present.

The analysis shows this rock to be the most alkaline of any of those analysed since it contains 11.4 per cent. of alkalies, the two oxides being in sub-equal proportions.

Analysis No. 2 (p. 149) is that of a trachyte occurring in syenite on the west side of Onawe Peninsula, near the junction of the syenite with the gabbro. In the hand specimen it is a pinkish rock, with felspar phenocrysts showing in a trachytic groundmass. Under the microscope the felspars prove to be both sanidine and anorthoclase, both somewhat altered by weathering agents. The groundmass consists partly of long felspar laths, frequently in sheaf-like bundles, which prove to be albite, and also a larger proportion of shorter forms with nearly straight extinction, and the denticulate margins and forked ends of anorthoclase. A small quantity of quartz is also present. There is as well a considerable quantity of brown iron ore, no doubt derived from the augite present. This is generally much altered, but an occasional individual shows that it is of the greenish aegerine-augite type. This rock resembles, in some respects, very closely the one described on page —- as coming from Heathcote Valley, the analysis of which is given.

The next analysis is from a dyke which occurs just north of the neck at Onawe Peninsula. It is about 2 m. wide, and strikes towards German Bay. Owing to its hardness it stands out on the shore cliff more than the basic agglomerate and other trachyte dykes with which it is associated. It is stained concentrically. and along the joint planes with iron oxide. Under the microscope the rock appears to be composed almost wholly of felspar, all of which has a lower index than balsam. The groundmass is of two types of felspar—(1) in long lath-shaped forms polysynthetically twinned, and with the extinction angle of albite, and (2) short or quadrangular forms untwinned, which are either sanidine or anorthoclase, but, judging from their wavy extinction and denticulate margins, probably the latter. The groundmass also contains numerous grains of greenish-brown augite, which are generally oxidised to iron ores, and stained with them. The phenocrysts are entirely of felspar, both sanidine and anorthoclase.

The analysis of this rock (No. 3 on page 149) is that of a somewhat acid trachyte, showing close relationship to that of the dyke from Quail Island (No. 2 on page 130), and that from Beach Road, Akaroa (No. 1 on p. 149). It is that of an almost pure felspar rock, coloured slightly with oxides of iron, and with decided bostonitic affinities.

Very many dykes cut the shore platform around Onawe, and are exposed between tide marks and on the adjacent hillsides, but those described may be considered as typical, not only of the locality

but of other parts of the shore line of the harbour. Dykes of exactly similar character occur at Tikao Bay, Wainui Island and Lushington Bay. The variations are chiefly in texture, the coarser varieties frequently having quartz present as grains in the groundmass.

(*b*) Basalts.

At Onawe these are intersected by a series of basic dykes; while it is not possible to say definitely which is the older; in general the basic variety seems to be the younger of the two. Analysis No. 4 (p. 149) is from a sample of one of them, which cuts across the peninsula just north of the neck, and outcrops on the shore on both sides. The dyke is about 2 m. in width, and it strikes approx. N.E. The rock is very decomposed where exposed to the weather, and specially so on the outside of the quadrangular blocks into which the mass breaks, which are externally of yellowish brown tint, though the inside kernel, when obtained in a fresh condition, is of a dark grey colour with no crystals showing distinctly, but with a somewhat glistening surface due to the presence of the felspars.

Under the microscope it shows a somewhat even-grained fabric of felspar laths and augite crystals, the two being sub-equal in size. The felspar is usually twinned with the extinction angle of andesine, but there are occasional more quadratic shaped crystals, untwinned, but with an extinction angle higher than balsam, and therefore a plagioclase of probably the same species. Their average length is about .5 mm. The augite is in longish crystals, and in grains without idiomorphic outlines, violet in colour and pleochroic, the longest crystal measured was .75 mm. in length. They show the sub-ophitic relationship to the felspar, the felspar having, as a rule, crystallised before the augite. Olivine grains occur rarely; there is much magnetite in grains as well as ilmenite in characteristic forms; apatite needles are a notable constituent. In some slides there is a considerable quantity of carbonate-filling cavities in the rock. The most noteworthy features of the analysis are the high percentage of titanium, a result to be expected from the occurrence of titaniferous augite, and the ilmenite or titaniferous magnetite present in the slide; the somewhat high percentage of soda, which is confirmed by the presence of the green soda augite; and the appreciable amount of phosphate. The analyst, in a note, says that the carbonate is not present as calcite, since there is no reaction with cold hydrochloric acid, only with hot acid. He considered the possibility of the carbonate being present as sodium carbonate in cancrinite, but I could not detect the presence of a felspathoid with certainty. The mineral, which looks like calcite, is, in all probability, dolomite, as might be expected is a somewhat decomposed rock containing a fair percentage of magnetium. The analysis is strongly reminiscent of those of the basic dykes of the Lyttelton system (Nos. 8 and 9, p. 130)

and belongs to a rock of teschenitic affinities. although it apparently contains no analcite or nepheline from which it might be derived. A number of dykes similar to this occur along the foreshore in the vicinity of the neck of Onawe Peninsula.

One of the dykes at Lushington Bay appears to be similar to this, but a trifle more basic, and should be classified as a dolerite. The texture is similar, the groundmass consisting of andesine-labradorite with violet augite and olivine grains, more numerous than in the case of the Onawe rock, and much magnetite. Occasional phenocrysts of labradorite up to 6 mm. in length also occur. There is in the groundmass a very small proportion of felspar of lower refractive index than balsam.

The following analyses have been made of the dyke rocks of this centre :—

		1	2	3	4
Silica	$Si O_2$	64.51	65.20	67.27	47.59
Alumina	$Al_2 O_3$	17.31	16.18	16.53	16.56
Ferric oxide	$Fe_2 O_3$	3.94	4.07	1.84	3.69
Ferrous oxide ..	$Fe O$	0.04	0.36	0.05	7.43
Magnesia	$Mg O$	0.12	0.36	0.16	3.51
Lime	$Ca O$	0.55	1.00	0.52	7.55
Soda	$Na_2 O$	5.66	6.38	5.35	4.14
Potash	$K_2 O$	5.73	4.26	5.08	2.07
Water lost above 105° C ..	$H_2 O+$	0.71	0.90	0.98	1.14
Water lost below 105° C ..	$H_2 O-$	1.19	1.05	1.40	1.00
Carbon di-oxide ..	$C O_2$	nil	..	nil	1.07
Titanium di-oxide ..	$Ti O_2$	0.33	0.15	0.38	2.76
Phosphorus pentoxide ..	$P_2 O_5$	0.06	..	0.18	1.01
Zirconia	$Zr O_2$	..	..	0.12	nil
Sulphur	S	..	..	nil	0.03
Chromium tri-oxide ..	$Cr_2 O_3$	..	..	nil	nil
Nickel oxide	$Ni O$	nil	..	nil	0.01
Manganous oxide ..	$Mn O$	0.01	0.08	trace	0.22
Strontia	$Sr O$	nil	..	nil	0.05
Baryta	$Ba O$	0.02	..	0.06	0.05
Totals ..		100.18	99.99	99.92	99.88

No. 1—Trachyte—Beach Road, Akaroa, on point past Boatsheds.
I. "5. 1. 3 (4) Phlegrose—Anal., F. T. Seelye
No. 2—Trachyte—Dyke in syenite, west side, Onawe, Akaroa.
I. 5. 1. 4 Nordmarkose—Anal., R. O. Page
No. 3—Trachyte—Dyke at Neck, Onawe, Akaroa.
I. 4". 1. 3 (4) Liparose—Anal., F. T. Seelye
No. 4—Basalt—Dyke at neck, Onawe, Akaroa.
II. 5. 3. 4 Andose—Anal., F. T. Seelye

D.—Summary.

The results obtained from this examination of the dyke rocks from both the main centres of eruption of Banks Peninsula show that many of them are of moderately alkaline type, trachytes predominating, and that there is a general gradation into andesites and into basalts, intermediate types occurring. Olivine is a noteworthy constituent of the andesites, and also of many of the trachytes, even of those of average composition. There seems to be some foundation for the statement that they may be regarded as differentiates from a slightly alkaline magma, which was erupted from both centres, and formed the two great volcanic mountains of the area. This is but another instance of the association of trachytic dyke rocks and occasional trachytic flows with lavas, which are basic in composition, an association which is typically exemplified in the rocks of Hawaii, and other Pacific Islands, the trachytes frequently occurring during the later stages of volcanic activity.

ADDENDUM.

It is not altogether foreign to this paper to record the recent discovery of fossils in sandstone at Charteris Bay on the southern side of Lyttelton Harbour. Up to the present those discovered are only moulds, no actual shells being obtained, but plaster casts show clearly the presence of certain forms similar to those of the Selwyn Rapids beds, and the sandstones are therefore, in all probability, of Upper Cretaceous (Senonian) age. These sandstones are penetrated by trachyte dykes. It is extremely likely that the discovery will result in some modification of the accepted ideas as to the stratigraphy of the area, particularly of the sedimentaries, and, perhaps, of the rhyolites, but this matter can be left for further investigation and report.

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ARCHÆOLOGY OF CANTERBURY.

II.—MONCK'S CAVE.

By H. D. Skinner, Otago University Museum.

About a mile east of Moa-bone Point Cave, described in the last issue of *Records*, the tramline from Christchurch passes close to an insignificant spur, on the further side of which is a small municipal yard. If the visitor alights from the tramcar at the neighbouring stop and walks to the inland end of the yard, he will there see what is left of Monck's Cave. As it has been mapped and described by Meeson it is not necessary to describe it here, beyond noting that it is much smaller than Moa-bone Point Cave, and has nothing approaching the depth of stratified deposit found there. Unlike its neighbour, the mouth of Monck's Cave had been sealed by a landslide in pre-European times.

The material found in Monck's cave is, in itself, much more interesting than that found at Moa-bone Point.* The scientific value of the material has, however, been impaired by failure to record the circumstances in which it was found. Meeson's account (1) is avowedly a preliminary general survey, to be followed by a more detailed description from the pen of Forbes. But since this has never been written, we are ignorant on several points of prime importance. It is, for example, clear that Meeson believed all the objects discovered were of Moa-hunter date, for he says (p. 68) "The quantity of fragmentary bones of fishes and of moa shows that these were the animals principally eaten by the natives inhabiting the cave." Forbes (2), in a brief paper on this subject, did not commit himself so definitely as Meeson, but he recorded that moa eggshell with the internal membrane adhering was found in the dust lying on the cave floor. The point involved is of importance, and it will be necessary to review the evidence, now very incomplete, before forming a judgment on it.

Sixteen pieces of moa-bone were received at the University Museum with the artifacts sent for examination. Four of these were ends of femora and tibiae of a bird or birds belonging to a small pieces, perhaps *Emeus crassus.* Four were broken but otherwise unworked pieces of the shafts of similar femora and tibiae. The remaining eight pieces were worked but species were indeterminable. Two were sharply pointed, and were probably awls, while the functions of the remainder could not be deter-

* As sent to the Otago University Museum in October, 1922, it lacked several of the articles specified by Meeson, e.g., greenstone pendant and chisels, "chelae" and fern-root pounder. These items are therefore not described in this paper.

mined. The condition of all these bones suggests that they were not found buried but on the surface of the cave floor with most of the rest of the artifacts, and were contemporary with such important and distinctive pieces as the bailer and the outrigger-float to be described later. This, however, proves nothing, for such bones were collected from ancient deposits and used in the manufacture of implements even as late as early European times. If ribs or vertebrae or other bones not utilisable in industry, or eggshell, were recorded as found in association with artifacts, then the artifacts might be classified with reasonable certainty as of Moa-hunter date. Unfortunately this was not done, and the manufactured articles from Monck's Cave must, so far as the Moa-hunters are concerned, be placed in a suspense account. The failure to record circumstances of discovery is the more to be regretted since Meeson describes stratification of deposits as apparent in the cave. "Here and there can be clearly traced layers—in one place as many as five—of various thicknesses, from 1 inch or 2 inches to 6 inches or 9 inches. These layers are of volcanic ash at top, and the debris of fires (ashes of wood, dirt beds, etc.) intercalated with a kind of silt or loess, apparently identical with that found here and there all round the peninsula. The second cave contained as its floor-covering nothing but a 3-foot thick bed of this silt or loess." The layers here described must have contained decisive evidence, but we have no record of their excavation. It seems probable that they were turned over when the cave was opened, in August, 1889, but it is possible that systematic excavation might even now produce important results.

The evidence of stratification in the cave weighs decidedly against the conclusion that surface finds, such as the bailer and the float, were of Moa-hunter age, for evidence secured at Moa-bone Point Cave indicates that the period since the moa was exterminated in Canterbury is seven times as long as the period during which it was hunted there, and the Moahunter bed did not exceed a foot in thickness. On the other hand, the entire ignorance of the existence of Monck's Cave on the part of local Maoris and the small total depth of deposit compared with that at Moa-bone Point indicate that bailer, float, and all else in the cave stand far closer in time to the Moa-hunters than we do.

Articles Found in Cave.

Bailer.

See Plate xxiii. Figured also by Meeson (1.c.) *and Hamilton* (3).

This is stated by Meeson (p. 68) to have been found, together with the large paddle, "immediately when the cave was opened,

in a kind of natural cupboard or cleft in the rocky side of the outer chamber.'' These two objects cannot, therefore, be older than the topmost of the five floor layers mentioned by Meeson.

Material—Meeson suggests *totara* (Podocarpus), a local timber.

Method of manufacture—The shape is such that the hollowing-out must have been a matter of considerable difficulty. Slight charring or scorching is visible on parts of the surface, but it is not known whether this is due to the use of fire in actual shaping or merely in hardening the final surface. The depth of the charring at the back of the inner surface of the bailer suggests that in that part fire may have been used in the shaping. If this is so, it is difficult to conceive any other method than the use of red-hot stones. The carving would be executed with a sharp stone chisel, probably of greenstone, set in a helve similar to that found in Moa-bone Point Cave (4).

Description—The outer surface of the back of the scoop is carved to represent a conventionalised human face, with slant eyes and protruding tongue. The rendering of the nose is unusual, and is perhaps a local peculiarity. The lips and brows are decorated with a series of carved loop-coils, which are carried forward almost to the lip of the scoop. The handle resembles those of many other Maori bailers in being shaped to represent the head of a bird, a method of decoration followed also in the Massim area, but it differs from all other Maori bailers that have been preserved in joining the side of the scoop. In occasional Maori bailers the beak joins the floor of the scoop.* The whole decoration, though lacking the fine cutting possible with steel tools, is excellent. A split has opened between floor and side of the scoop and has been prevented from spreading by three flax ties passing through three pairs of holes. On the outside, where exposed to friction, the ties are neatly countersunk. The bailer has been coloured with hematite, but the paint has everywhere worn off, being present now only in cracks and hollows.

The presence in this district of a bird's head and loop coils, at present known from this specimen only, is of considerable importance in working out the history of decorative art in New Zealand.

---

* In a bailer from from the West Pacific in the Otago University Museum, handle and scoop-edge are confluent, the former being shaped like a human foot. A bailer from Kiriwina in the National Museum, Melbourne, shows the same feature, but the handle is decorated with a bird's head.

Paddle.

(See Plate xxiv. Figured by Meeson.)

Material—Stated by Meeson to be *kauri* (*Agathis aust.*).

Method of manufacture—No signs of fire can be detected, and it is to be supposed that the paddle was made by splitting, adzing, smoothing, and carving.

Description—Its dimensions suggest that it was used as a steering paddle. The handle is circular in section, tapering slightly upwards, the top being uncarved. The junction of handle and blade (Plate xxiv. a) has several points of interest from a comparative point of view. The handle is continued by a ridge which divides in two, the ends being united by a cross ridge carved roughly as two fused circles. Towards the lower end is a decoration carved in low relief, suggesting human eyes (Plate xxiv. b). The point of the blade is thickened. The paddle is in process of repair. A long split down the middle of the blade has three pairs of holes, evidently for binding, but without cord. A smaller split is similarly treated, but the lowest pair of holes is incomplete. The holes, which vary considerably in neatness, have all been perforated from the convex surface of the blade. Two have obviously been drilled, the remaining six being doubtful. There are five bands of red paint across the concave surface of the blade.

Carved Head of Paddle.

(See Plate xxiv., Fig. 2. Figured by Meeson.)

Material—Species of wood not determined.

Method of manufacture—After carving, the surface has been slightly charred, either for decorative purposes (as so often in the West Pacific), or for purposes of preservation.

Description—The carving represents two froglike un-Maori faces, linked by what appear to be arms. They are probably a development of the distorted *tikis* sometimes seen on the handles of Maori paddles. The carving has been broken from the handle, and a mortise has been cut for the purpose of rebinding.

Outrigger Float.

(See Plate xxv.)

Material—Species of wood not determined.

Manufacture—The wood appears to have been adzed out and then hardened by slight surface charring.

Description—Dimensions and general shape are given in the drawing. A notable feature not very clearly indicated is the canoe-shape of the ends which thus have a distinct keel. The stanchion pits are sunk vertically, and are $3\frac{5}{8}$, $3\frac{3}{4}$, and $3\frac{3}{4}$ inches apart respectively. If the sticks were inserted vertically in these pits they must have been attached to a boom $3\frac{3}{4}$ inches in diameter, that is, a boom more massive than the float itself. Between each pair of stanchion pits two holes have been sunk, which converge and meet. Through each of these holes a cord must have passed, attaching float to boom. This method of attachment is not described by Haddon (5) or Hornell (6) in their comprehensive papers on the outrigger, but a similar method was noted in a canoe model from the Admiralty Islands in the Australian Museum, and in a model from Samoa in the Otago University Museum. But in these cases, the cord passed round the float, not through a hole in its upper surface.

This float is of special importance as the only New Zealand example which has been preserved.

Adzes.

Seventeen commonplace adzes were found, the greater number appearing to be unfinished, and showing the marks of polishing with coarse sandstone. On the whole, they are less massive than might have been expected, and exhibit rather poor workmanship. The most distinctive (Plate xxvi., Fig. 4) is allied to a type common to the Hawaiian Islands. Several adzes are distinctly Polynesian in form, while none are of West Pacific types. One of the adzes is worn down by an immense amount of use. One implement is gouge-shaped.

Cutters and Polishers.

Six pieces of sandstone have been used as polishers or as cutters. Of these only one is of characteristic shape, and this resembles a type common in Otago.

Flakes and Saws.

Seven flakes of volcanic glass were found. The material was of good quality, and must have been brought from the Bay of Plenty district in the North Island.

Of five pieces of flint, three were probably knives, one with chipped serrated edge was probably a saw, while the last appears to be a core. The source of this flint was probably the Amuri Bluff.

One flake and one core were of chalcedony, which is found in the foothills of the Alps.

Nephrite.

Of the seven pieces of nephrite found, four were fragments. One is a half-finished gouge with mud from the grinder still adhering. Two are small characterless adzes.

The nephrite is all light-coloured and mottled, and looks as though taken from a single boulder.

Other Rocks.

There are a number of other rocks in the collection, but the only one which is of interest is a piece of red argillite ground smooth, as though to be made into a broad breast-pendant. This material is found in the valley of the Waitaki.

Fish-hooks.

One-piece hook—There is one example of this type, made of moa-bone, strongly and coarsely shaped, except the knob and groove for line attachment, which are neatly cut. The barb, or recurved point, is broken. This type appars to be represented in all parts of New Zealand. (Plate xxviii.).

Points of composite hooks—There are four curved unbarbed bone points (Plate xxviii.) of what are usually described as barracouta hooks. These points are common throughout the South Island, but I have never seen them fitted into the appropriate wooden shank. There are two stout barbed points and two smaller ones such as are found in all parts of New Zealand Plate xxviii.). There is a butt of a bone point perforated for attachment, of the type usually attached to a stone shank (7).

Wooden shanks of composite hooks—One of these (Plate xxvii., Fig. 6), broken at lower end, is of a type represented by four examples from Moa-bone Point (8). The remaining three straight wooden shanks (Plate xxx., Fig. 12) all appear to be unfinished. Their type is represented at Moa-bone Point, and appears to have been common in Otago.

Stone Sinkers.

There were two grooved sinkers.

Bone "Gorges."

There are two objects (Plate xxviii.) of the kind whose use is not definitely known, but which in the past has usually been described as a fish gorge. (Mr. Johannes Andersen will discuss these objects in a forthcoming paper in the *Journal of Science and Technology*).

Bone Needles.

One of these is the lower part of a straight needle which has been broken. It has been re-drilled from both sides. Diameter at mouth of hole less than 2 mm. The remaining two objects classified as needles are made from mammalian ribs, and may in reality be mat-pins.

Bone Heads of Bird-spears.

Of the 29 barbed bone heads of bird-spears (Plate xxviii) 10 are in practically perfect condition. All of these are made of wing-bone. Nine have a single row of barbs, and one has three barbs along one edge and two along the other. None of the single-row examples have any special modification at the butt to hold the lashing which bound the bone point to the wooden shaft. The double-barbed example has two notches on the butt, presumably to hold the binding. The ten heads range in length from $5\frac{1}{2}$ in. (7 barbs) to 2 in. (2 barbs). Most of the broken heads appear to be made from mammalian bone, some of it human. Three of them show serrations on the lowest barb, indicating that the binding which secured bone point to wooden shaft passed round the butt and as far up as the first barb. Some examples in the Otago University Museum show serrations on the second barb, indicating, apparently, that the binding covered it too. Occasional examples show serrations on all barbs and along the back. In this case the serrations are purely ornamental. As no complete examples of bird-spear from the South Island, nor even of wooden shaft, have been preserved, conclusions as to method of fastening have to be based on examination of the bone points.

Wooden Shafts of Bird-Spears.

Two slender pieces of wood, circular in section and broken at either end, the longer being 3 ft. 9 in. in length, were perhaps parts of bird-spear shafts. The Otago Maoris say that their shafts were composed of sections which were tied together in the bush at the tree where spearing was to take place.

Fire-making.

The species of tree used for the six pieces of fire-making apparatus could not be determined. The "bed" was represented by two pieces, one of which, though only $3\frac{3}{4}$ in. long, had six grooves; a good piece of wood was evidently treasured. The other is $8\frac{1}{2}$ in., and shows four grooves. The "rubbers" or "ploughs" are $3\frac{1}{4}$ in., $5\frac{1}{4}$ in., 6 in., and $8\frac{1}{2}$ in. in length respec-

tively. One is shaped as figured (Plate xxvii., Fig. 7). One is made from part of a fish-hook shank.

Wooden Beaters.

These implements were described in the catalogue as "eel-killers," but so far as at present known, eel-killers are all sharp-edged. The smaller example (Plate xxix., Fig. 9a) shows marks of stone chisel on handle; the head shows no evidence of use. This might be a toy. The larger example (Plate xxix., Fig. 9b) has had much use, presumably as a fern-root beater. Its upper surface is scored with lines, apparently the result of smoothing with very coarse sandstone.

Toy Canoe and Paddle.

There is no record that these (Plate xxvi., Fig. 3) were found together. The little paddle is painted red, but shows no other detail of interest. The other objects may perhaps be a toy canoe. I cannot suggest any other use. But if so much care has been used in making it, why is it not more like a canoe?

Toy Dog.

This little wooden toy, the only one of its kind at present known, is very carefully made, and displays some spirit in the rendering. The dog is male. The tail is curled over till it touches the back. The legs are relatively short. The nature of the hair is not indicated. The ears are apparently pricked. The toy thus confirms the accounts of Maori dogs by early navigators. (Plate xxxii.).

Pendant.

This is made from a vertebral epiphysis of one of the bony fishes, probably the tunny. The outer edge has been ground down and then ornamented with groups of notches, delicately cut. (Plate xxix., Fig. 10.).

Hair Combs.

One complete wooden comb (Plate xxix., Fig. 11) and four fragments were found. One of these (Plate xxix., Fig. 11a) has a curved upper margin, the cutting of which must have involved great technical skill. Another exhibits an unusual angular decoration (Plate xxix., Fig. 11b). A third has a slight rectilinear decoration carved in low relief (Plate xxix., Fig. 11c).

Wooden Weapons.

These are represented by two fragments, one being part of the blade of a weapon of the *taiaha* or *pou-whenua* type, while

the other may be the point of a spear of the *tao* type. The latter has been hardened by charring.

Miscellaneous Wooden Pieces.

Many of these are too fragmentary to be identified. There is the end of a spar (Plate xxvii., Fig. 8) beautifully mortised to hold an extension, the nature of which is suggested in an article by Dr. Buck (9). A small piece of squared timber has been dressed by an adze which had a distinctive chip on the cutting-edge; this chip has left its mark on all the dressed faces. There is also a piece, shown in Plate xxxi., Fig. 14, the use of which is not evident.

Broken Wooden Bowl.

The bowl (Plate xxxi., Fig. 13) is of the ordinary Canterbury-Otago type. It is made from a piece of wood with knots which have forbidden fine finish. An unusual feature is a small hole drilled in the forward edge. Length 12 in. Maximum width probably 6 in. The collection of material within the bowl consists principally of stems and blades of grass and flax, one small whole plant with roots being included. At the bottom is part of a sandal of the type figured from Moa-bone Point Cave. There are also several pieces of two- and three-ply cord, some of them probably belonging to the sandal. Wrapped up in this mass are part of the lower jaw and part of the right radius of a small dog. To what extent this bundle is due to the Maoris or to the European explorers is not clear. That the latter had some hand in it is proved by the presence within the bundle of pieces of skin with fur attached, which are mentioned by Meeson, but which were invisible before the bundle was opened. There are a number of little bunches of short hair ranging from cream to brown, which seem to have been pulled out by the roots. A piece of *manuka* bark, a few feathers, some human hair, and a number of unidentifiable blades of flax or grass, complete the bundle.

Haliotis Shells and Contents.

The contents of one large shell are as follows:—A fragment of 3-ply rope, 7 mm. across, made of dressed flax; fragments of 2-ply rope made of undressed flax; a fragment of bark; two fish-bones; 15 feathers of varied species; a patch of feathers from which the skin seems to have decayed away; several bunches of fine yellow and brown hair, probably canine, which seems to have been pulled out by the roots; pieces of perished flax; a bunch of human hair. At the bottom of the shell is a layer of

dry earth. The shell lies in a larger one, the holes of which are stopped with flax fibre.

Another haliotis shell contains bird bones and some vegetable substance too perished to be identifiable. Other shells contain fish-bones, vegetable matter, and a piece of very fine 3-ply plait, 1·5 mm. across.

Another shell has been used as a paint box, and contains red oxide of iron.

Shells from Refuse Heaps.

Mr. Harold Finlay, M.Sc., was good enough to examine the thirteen shells preserved. He states that they comprise *Pecten medius, Chione stutchburyi, Haliotis iris, Mesodesma novae-zealandiae, Turbo helicinus,* and *Scaphella pacifica.* These are all local species, but many more kinds must have been used as food.

Matting.

A small fragment of finely-plaited chequer matting (Plate xxxi., Fig. 15).

Human Hair.

One of the most interesting discoveries in the cave was a series of cuttings of human hair. As there are no details of the finding, one can only speculate as to the circumstances which led to the deposit of material so highly *tapu* as human hair in a cave used for meals and daily life.

One bunch of hair represents the cutting of a very heavy head. It is dark brown, of medium texture, waved or even ringletted. With it is some white dog's hair.

Another bunch, of the same character as the last, is at present associated with brown and white dog's hair, feathers, and bark. Part of this bunch has been plaited in a group of 2-ply threads.

The third bunch is much lighter in colour—chestnut—finer in texture, and ringletted. With it is a piece of beautifully plaited hair.

The fourth bunch is coarser, chestnut, slightly waved, well combed, and about 14 in. long.

In the remaining bunch various individuals appear to be represented, and the hair is associated with dog's hair, feathers, plaited fibre, and *hohere* bark.

All finds of importance are believed to have been noted above.

Conclusions.

1. Monck's Cave had been occupied by the Moa-hunters, but the evidence is against the conclusion that the more spectacular

finds, *e.g.*, bailer, and outrigger float, are of so early a date. It is virtually certain that some of the implements in the collection belonged to the Moa-hunters, but the absence of any records of the circumstances of discovery makes it impossible to assign any object definitely to them.

2. The cave has been sealed for a considerable period, amounting perhaps to centuries.

3. There is no evidence of any change of culture between the first occupation of the cave and its sealing up.

4. The outrigger float is at present unique in New Zealand.

5. One feature of the bailer—the confluence of handle and side—is without parallel in New Zealand. The presence at Banks Peninsula of a decorative scheme based on spirals is of considerable importance in the study of the history of Maori decorative art. This is at present the only recorded bailer from the South Island of New Zealand.

6. The human hair indicates considerable variation in pigmentation in the ancient population, and the very fine plaiting that occurs indicates Polynesian relationships.

7. Trade relations with the Bay of Plenty, Westland, and the Waitaki valley are indicated by some of the rocks present.

Bibliography.

(1) Meeson: *Trans. N.Z. Inst.*, xxii. (1889), p. 64.
(2) Forbes: *Trans. N.Z. Inst.*, xxiii. (1890), p. 373.
(3) Hamilton: *Maori Art*, Plate ix., b.
(4) Skinner: *Records Canterbury Museum*, II. (1923), Plate 18, No. 6.
(5) Haddon: *J.A.I.*, L., p. 69.
(6) Hornell: *Madras Fisheries Bulletin*, XII., pp. 43–114.
(7) Skinner: *Journal of Polynesian Society*, xxxiii. (1924), Fig. 10, L.
(8) Skinner: *Records*, II. (1923), Plate xviii., Nos. 2, 3, 5, 6.
(9) Buck: *Trans. N.Z. Inst.*, liii. (1921), Fig. 3, p. 446.

Note on the Species of Moa Hunted by the Maoris.

In two papers on Moa-hunter camps cited in the preceding article (Nos. 4 and 7), I followed Hutton in rejecting Haast's evidence on the finding of bones of *D. robustus* at Moa-bone Point, and *D. ingens* at the Rakaia mouth, in both cases associated with human artifacts. I have since found that Hutton quietly and without announcement withdrew from this position. In his great paper on the classification of the moas (*Trans. N.Z. Inst.*, xxiv. (1891), p. 93 ff) he notes the following species as

occurring in middens:—*D. robustus, D. firmus, D. gracilis, D. struthioides; A. didiformis; S. rheides* (?); *S. casuarinus; S. crassus; E. elephantopus, E. ponderosus, E. gravis.*

The nature of the evidence as to association of these species with man is not given, but Hutton's statement must be accepted until good evidence to the contrary can be produced.

EXPLANATION OF PLATES.

(The scales to the figures represent inches.)

Plate XXIII.

Bailer.

Plate XXIV.

Fig. 1—Paddle.
Fig. 2—Carved Head of Paddle.

Plate XXV.

Outrigger Float.

Plate XXVI.

Fig. 3—Toy Canoe and Paddle.
Fig. 4—Adze, Hawaiian Type.

Plate XXVII.

Fig. 5—Adze.
Fig. 6—Wooden Shank of Fishhook.
Fig. 7—Fire Plough.
Fig. 8—End of Spar, mortised.

Plate XXVIII.

Bone Bird-Spear Heads.
Fish Gorges.
Fish Hook, and
Points of Composite Hooks.

Plate XXIX.

Fig. 9—Wooden Beaters.
Fig. 10—Pendant.
Fig. 11—Hair Combs.

Plate XXX.

Fig. 12—Wooden Shanks of Composite Hooks.

Plate XXXI.

Fig. 13—Broken Wooden Bowl.
Fig. 14—Unidentified Wooden Fragment.
Fig. 15—Matting.

Plate XXXII.

Toy Dog.

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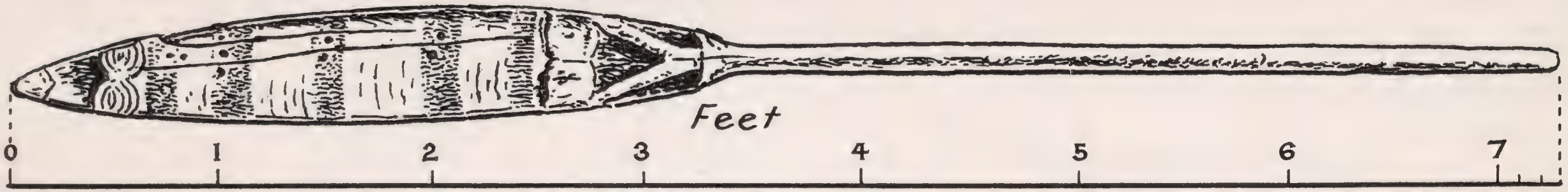

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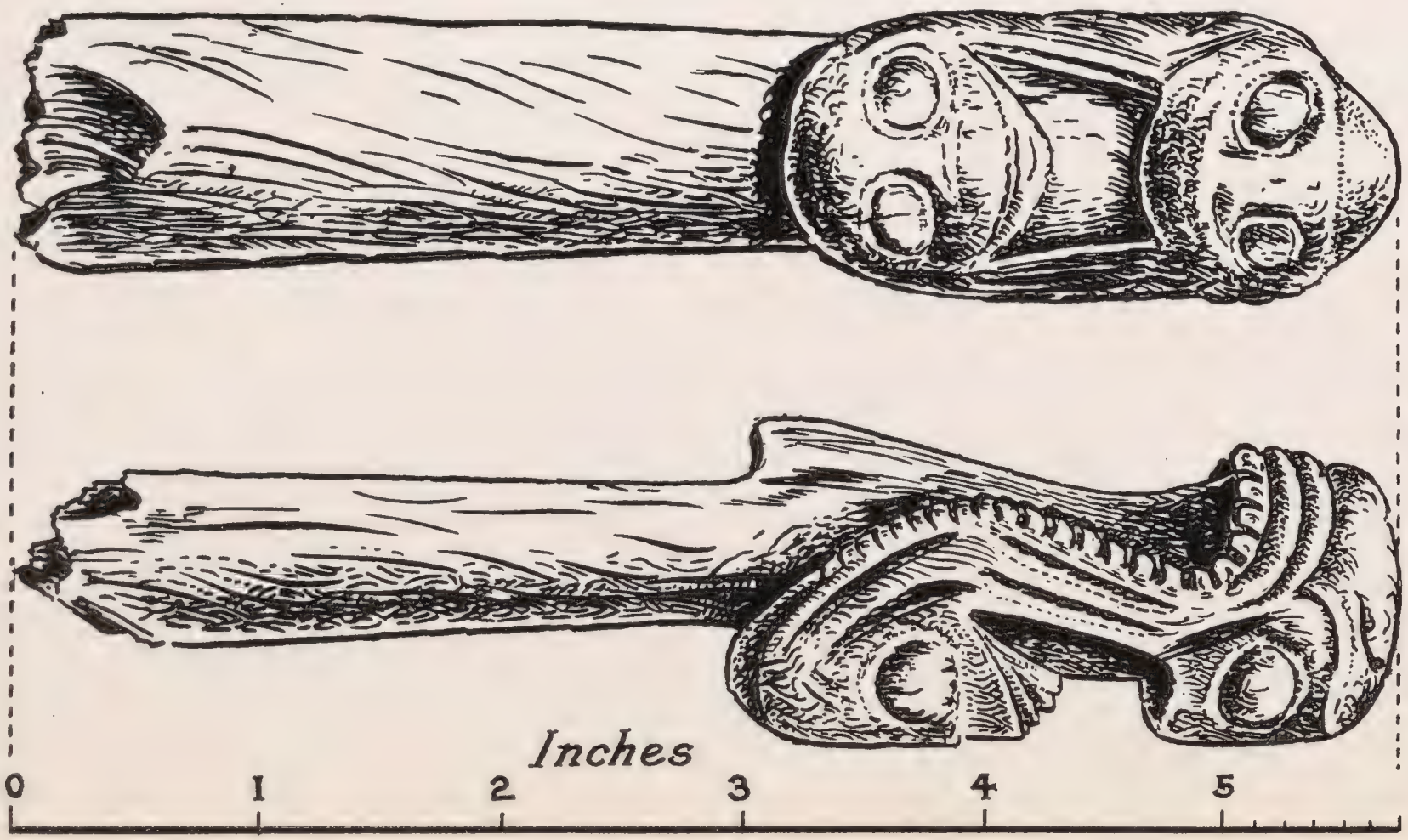

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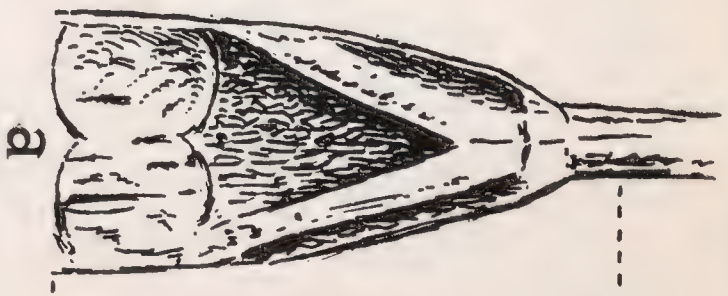

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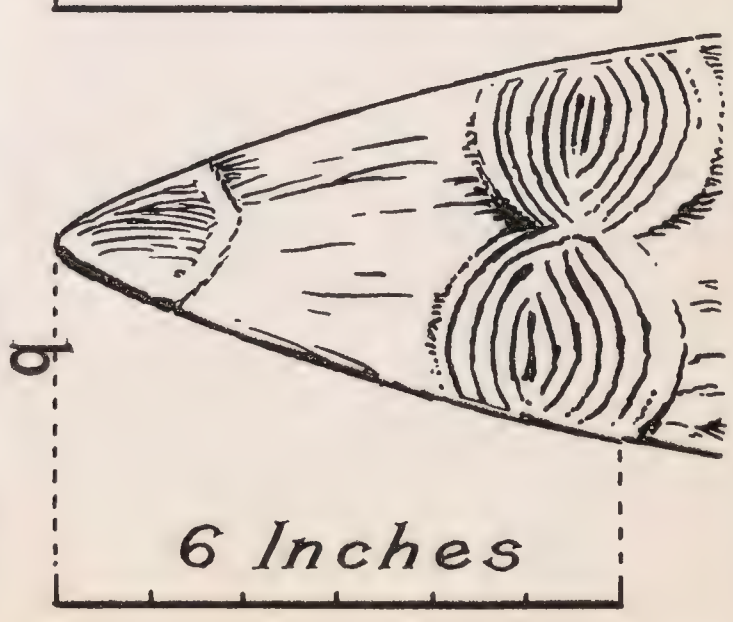

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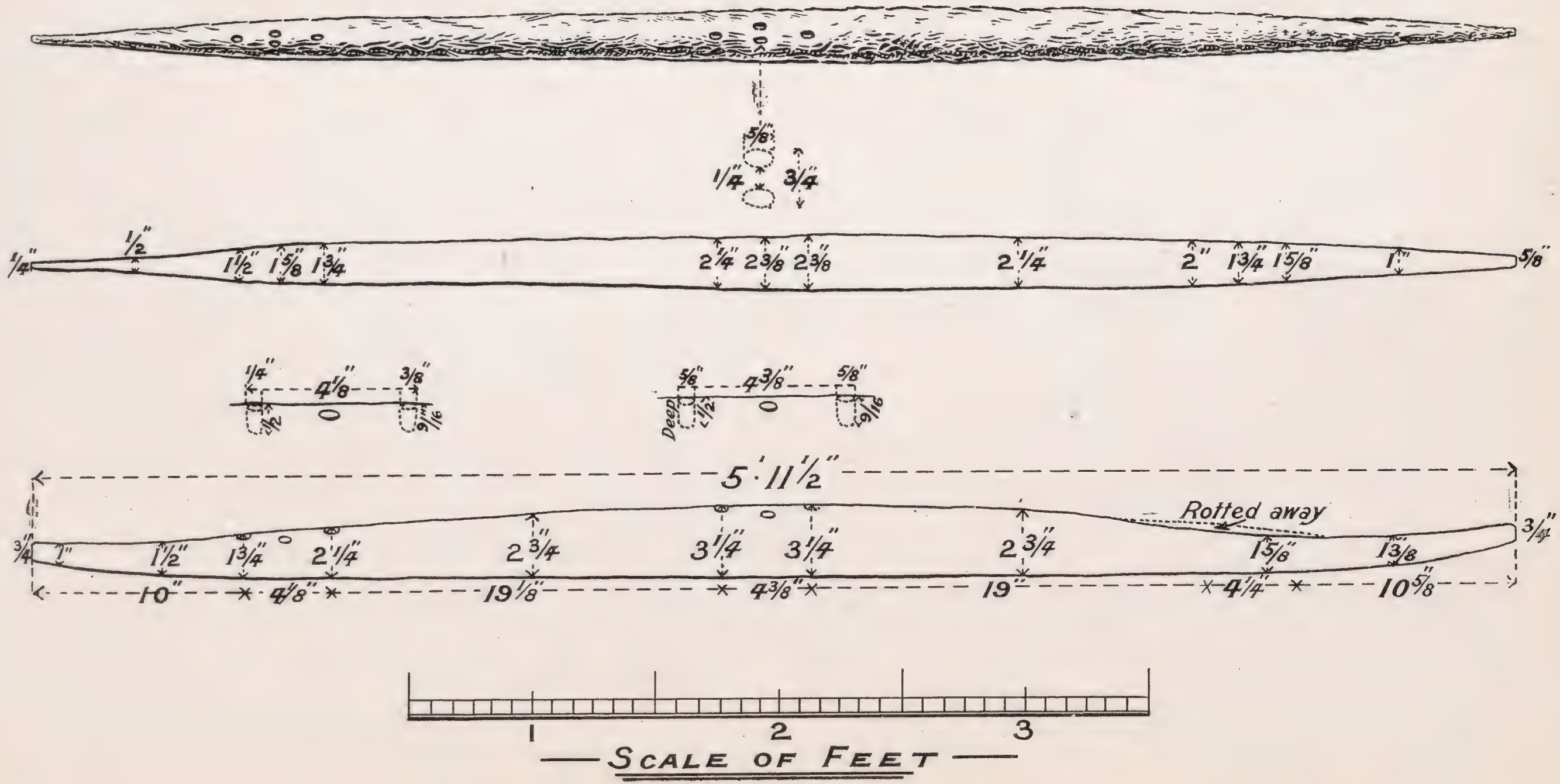
PLATE XXIV.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SCALE OF FEET

PLATE XXV.

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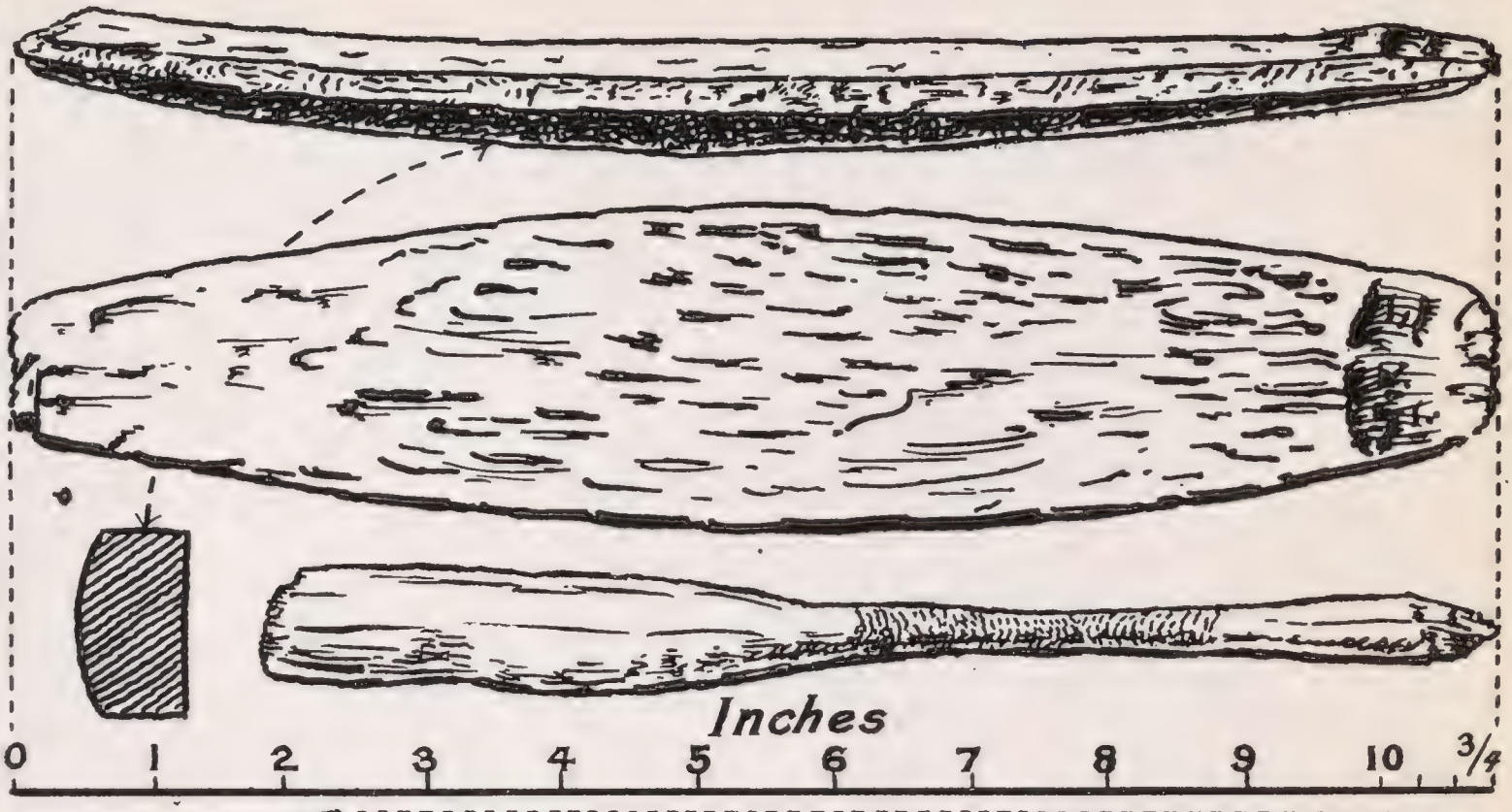

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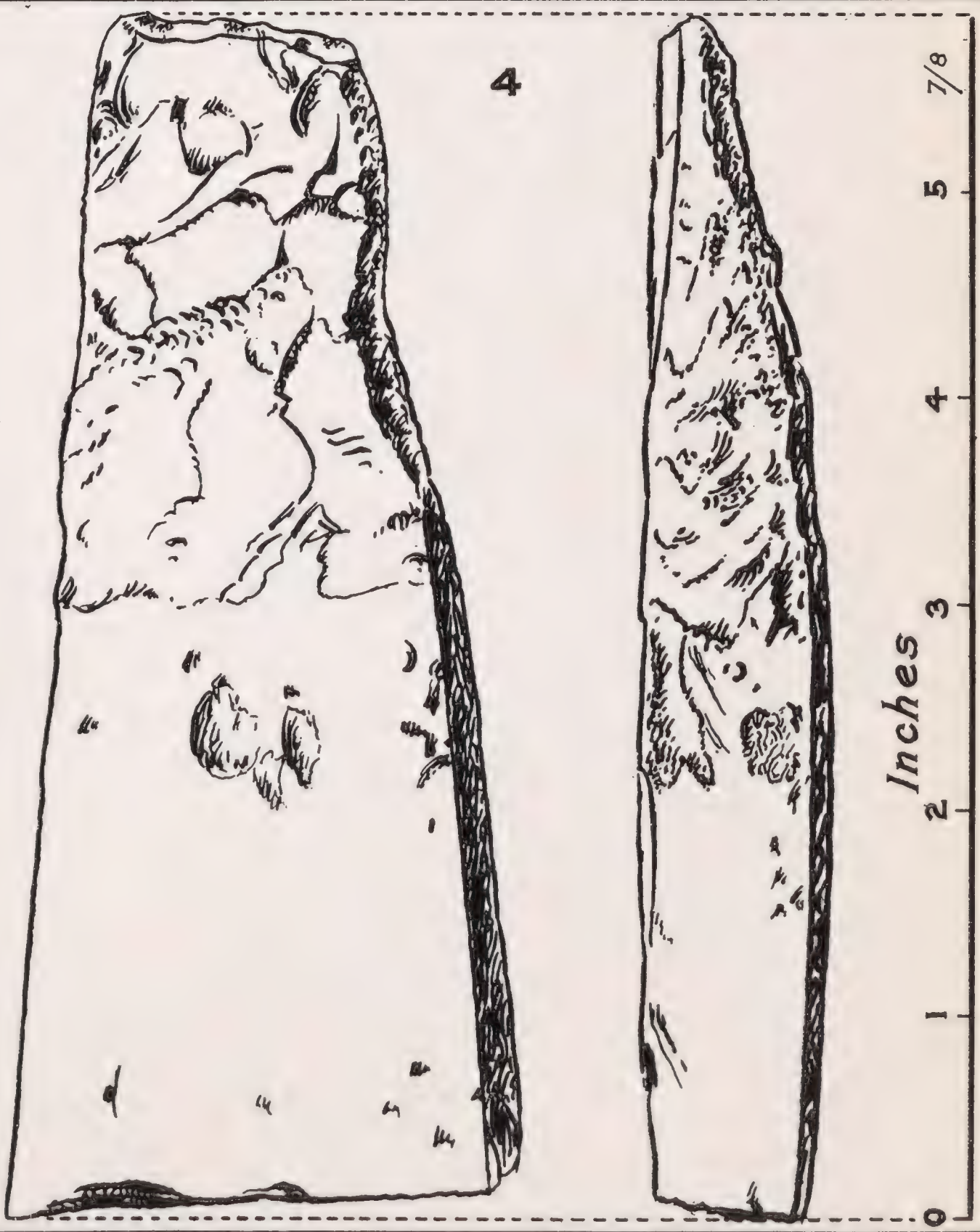

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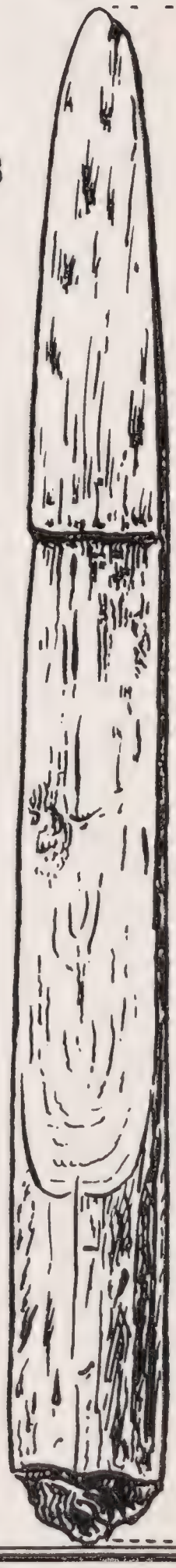

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Plate XXVIII.

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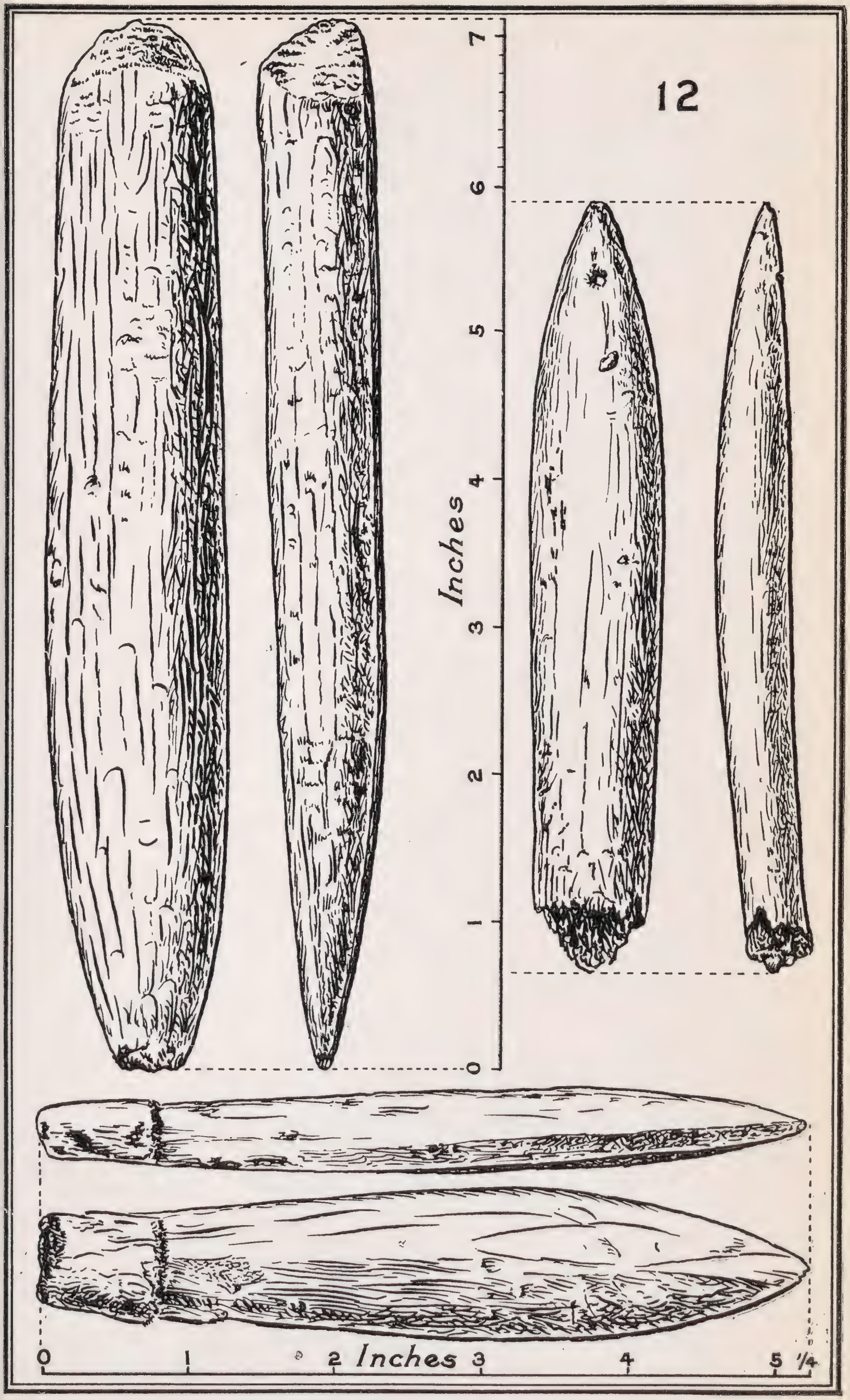
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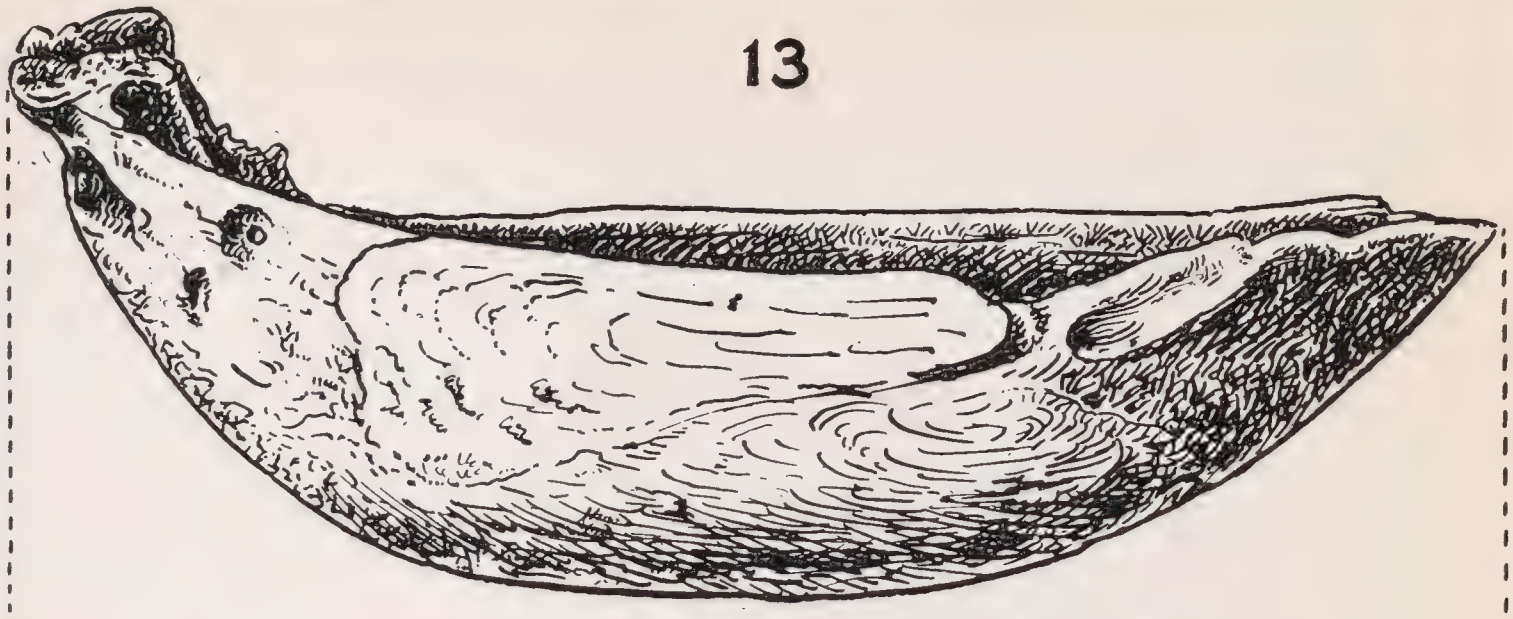

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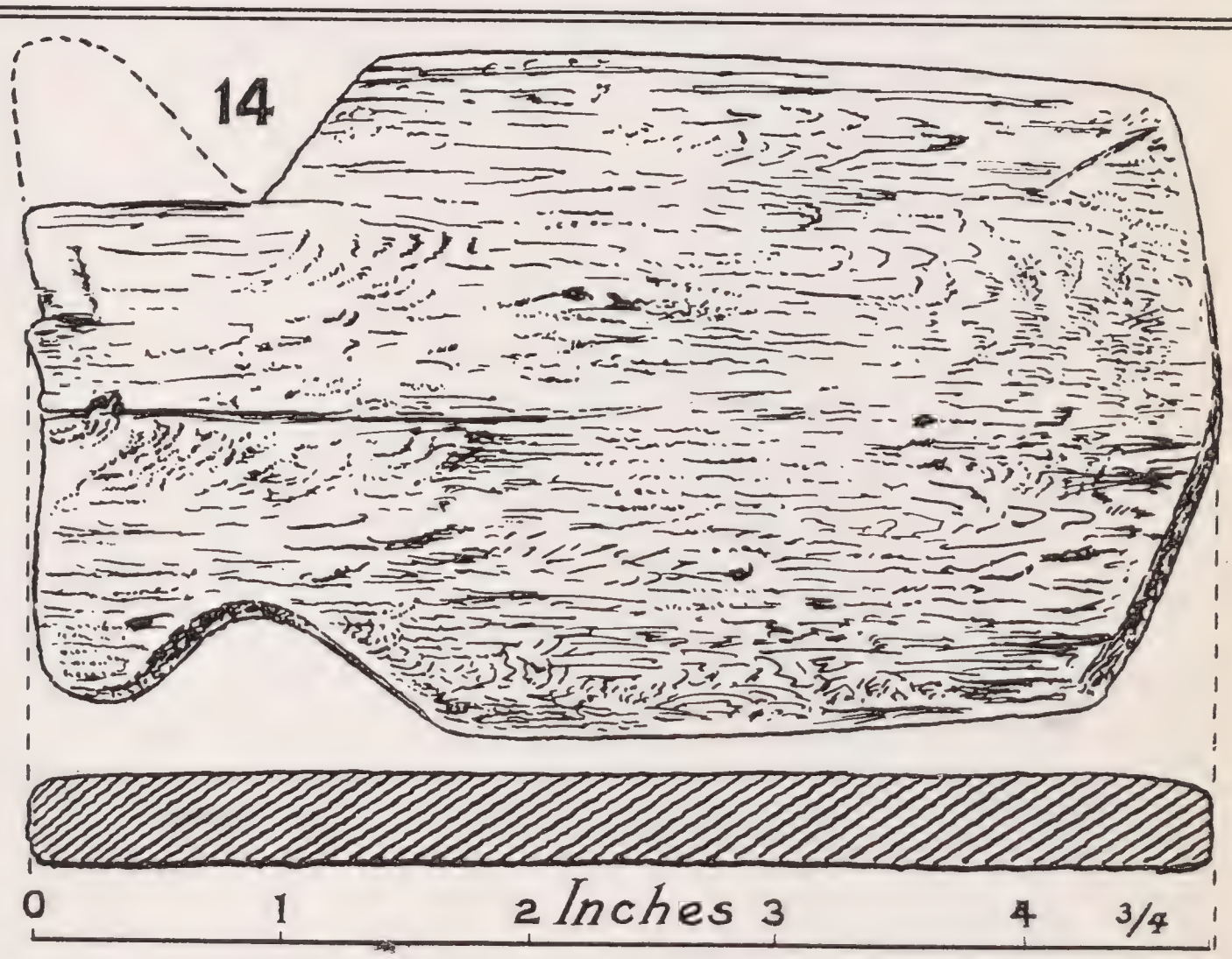

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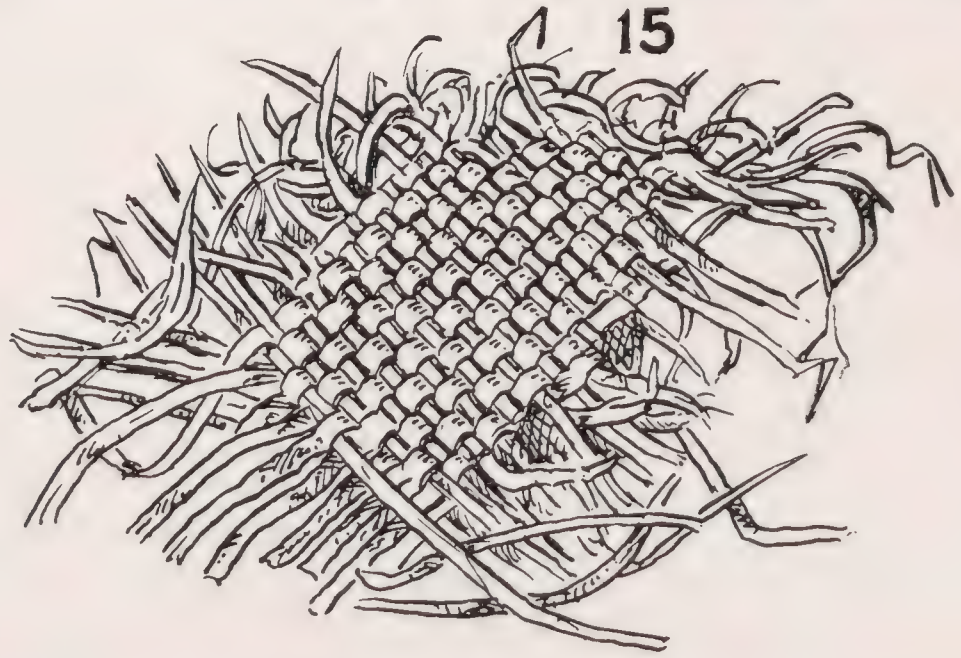

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THE CRANE-FLIES OF THE CHATHAM ISLANDS (NEW ZEALAND)

(*Tipulidae, Diptera.*)

By Charles P. Alexander, Massachusetts Agricultural College, Amherst, Massachusetts, U.S.A.

The collections of Tipulidae made by Messrs. Gilbert Archey and Charles Lindsay, of the Canterbury Museum, while members of the recent scientific expedition to the islands, have been kindly submitted to me for determination by Mr. R. Speight. My sincere thanks are extended to Director Speight and the collectors of the material for the privilege of examining these interesting collections. The holotypes and uniques are preserved in the collection of the Canterbury Museum.

No species of crane-flies had been recorded hitherto from these islands, and the present material is of great interest in confirming the close relationship of the fauna and flora with the New Zealand mainland.

The Chatham Islands, consisting of the four principal islands, Chatham or Wharekauri, Mangere, Pitt or Rangiauria, and South-east, lie due east of Banks Peninsula, and approximately 445 miles from Cape Palliser, Cook Strait. The main island, Chatham or Wharekauri, is occupied largely by the extensive Te Whanga lagoon. The greatest altitude is about 940 feet. The climate is purely maritime, since no part of the main island is more than four miles from the ocean. The mean annual rainfall is a little more than 38 inches, deposited over an excessive number of days, especially during the winter. The winds are generally strong, and mostly westerly with a southerly tendency, which might explain in part, at least, the very evident affinities with the main islands of New Zealand. The mean annual temperature is 10° C. Frosts are extremely light and rare, while snow is seldom seen. The florula of the Chatham Islands, as recorded by Cockayne, includes 240 species, in 141 genera, belonging to 56 families. Of these species, 33, with 2 genera, are endemic, the great majority of the others being New Zealand species, over half of these, in turn, being common to New Zealand and Australia. Ten per cent. are Australian-South American in their affinities. Detailed accounts of the climate and plant ecology of the islands may be found in Cockayne.*

The crane-flies collected by Archey and Lindsay include 10 species distributed in the following 6 genera:—*Dicranomyia* (5), *Discobola* (1), *Limnophila*, s.l. (1), *Gynoplistia* (1), *Molophilus* (1), and *Amphineurus* (1). All of the above show note-

* Short Account of the Plant Covering of Chatham Islands. Trans. N.Z. Inst., xxxiv., 1901, p. 243.

worthy affinities with the New Zealand mainland, the species either being common to the main islands or else finding their nearest relatives there. Four species, *Dicranomyia archeyi, D. lindsayi, Discobola chathamica.* and *Gynoplistia chathamica,* are described herewith as new, and must be considered as being endemic, although the two species of *Dicranomyia* may later be found to occur on the main islands of New Zealand. It is probable, however, that the species of *Discobola* and *Gynoplistia* are endemic relicts of an ancient palaeozelandic Tipulid fauna. *Dicranomyia conveniens* (Walker), *D. gracilis* Edwards, *D. nebulifera* Alexander, *Limnophila oliveri* Alexander, and *Amphineurus hudsoni* Edwards occur also on the main islands of New Zealand, and it is problematical as to how they reached the Chathams. In the case of *D. nebulifera,* at least, it is entirely possible that the species was carried from the mainland to the Chathams by modern transportation, a belief that is suggested by the discovery of the type-specimen, a large female, on the engine of the steamer *Ngatoro,* trading to the Chathams from Lyttelton.

FAMILY TIPULIDAE.

Sub-family Limoniinae.

Tribe Limoniini.

Genus DICRANOMYIA Stephens.

Diocranomyia archeyi, sp. n.

Belongs to the *vicarians* group; mesonotum dark reddish brown without darker markings; femora almost unicolorous brown; wings subhyaline, the stigma pale; abdominal tergites very indistinctly bicolorous, the apices of the segments only a trifle darker than the bases; male hypopygium with the spines of the rostrum unequal in size, widely separated.

Male.—Length about 7 mm.; wing 7·8 mm.

Female.—Length 7·5 mm.; wing 8 mm.

Rostrum and palpi brownish black. Antennae brownish black throughout, the flagellar segments oval. Head dark grey above, more reddish on the occiput and genae.

Pronotum reddish brown, a little darker medially. Mesonotum dark reddish brown, a little brighter laterally, without darker markings; median area of scutum and the scutellum more testaceous yellow; postnotum yellowish. Pleura pale yellowish testaceous. Halteres pale, the knobs infuscated. Legs with the coxae and trochanters testaceous, strongly tinged with greenish; femora pale brown, the bases indistinctly paler, with

a scarcely evident paler subterminal ring; tibiae and tarsi brown. Wings subhyaline, cells *C* and *Sc* a trifle brighter; stigma a little darker, yellowish; veins brown. Venation: Sc_1 ending opposite the origin of *Rs*, Sc_2 a short distance from the tip, Sc_1 alone shorter than the basal deflection of Cu_1, the latter at the fork of *M*.

Abdominal tergites brown, the apices of the individual segments a trifle darker than the bases, but in most cases producing a unicolorous effect; basal sternites a little paler. Male hypopygium with the tergite gently emarginate posteriorly. Basistyle relatively small, the mesal lobe very large and stout. Ventral dististyle fleshy, large, the rostrum slender, with two widely separated spines, the outer one stout, the basal spine slender, arising from a hyaline papilla; apex of rostrum beyond the outer spine stout, the apex obtuse; dorsal dististyle rather strongly curved, sickle-shaped. Gonapophyses with the mesal apical lobe long and slender, darkened, the margins weakly denticulate, especially the lateral margin.

Habitat—New Zealand (Chatham Islands).

Holotype, ♂, Maunganui, *Dec.* 16th, 1923 (Gilbert Archey).

Allotopotype, ♀.

Paratopotypes, 4 ♂ ♀.

This interesting crane-fly is named in honour of the collector. *Dicranomyia archeyi* seems to be more closely allied to *D. crassispina* Alexander than to any other described species of the main islands. One of the paratypes has the stigma of the wings considerably darker than the types, and it is possible may not be conspecific.

Dicranomyia nebulifera Alexander.

1922 *Dicranomyia nebulifera* Alexander; *Ann. Mag. Nat. Hist.*, (9) **X**: 83–84.

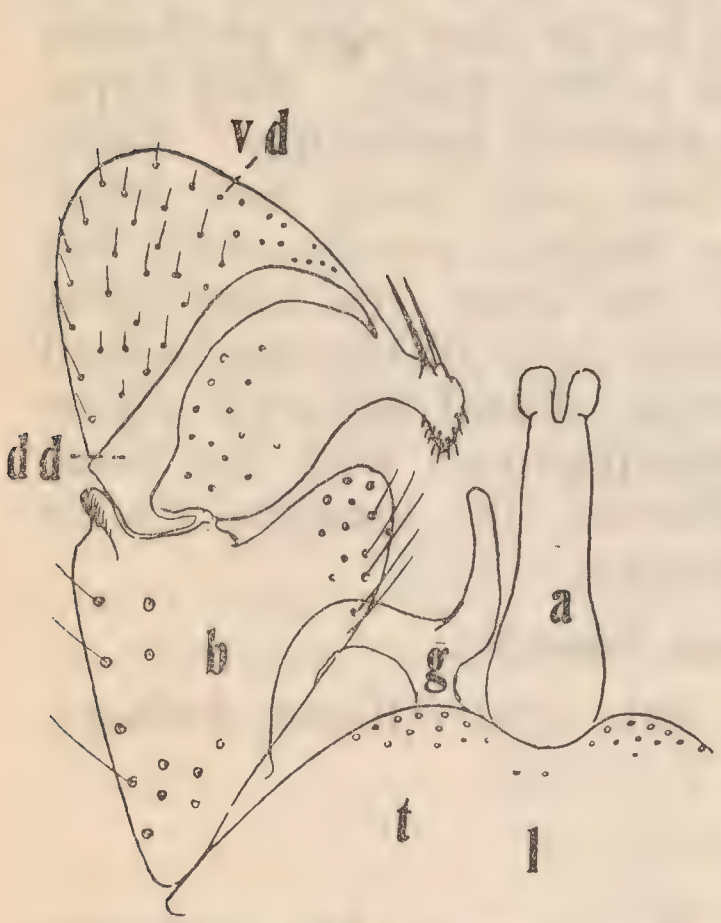
A male from Manukau, Chatham Islands, *Jan.* 1–2, 1924 (Charles Lindsay). The fly was described from Canterbury, where it has since been taken in small numbers. It is also known from Westland. The male hypopygium (fig. 1) has the ventral dististyles (vd) relatively small with a conspicuous fleshy rostrum that bears two long, slender spines, each arising from an enlarged papillose base. The dorsal dististyle (dd) is constricted near mid-length, the slightly enlarged outer portion prolonged into a long, straight beak that is weakly decurved at apex. Ninth tergite (t) distinctly emarginate.

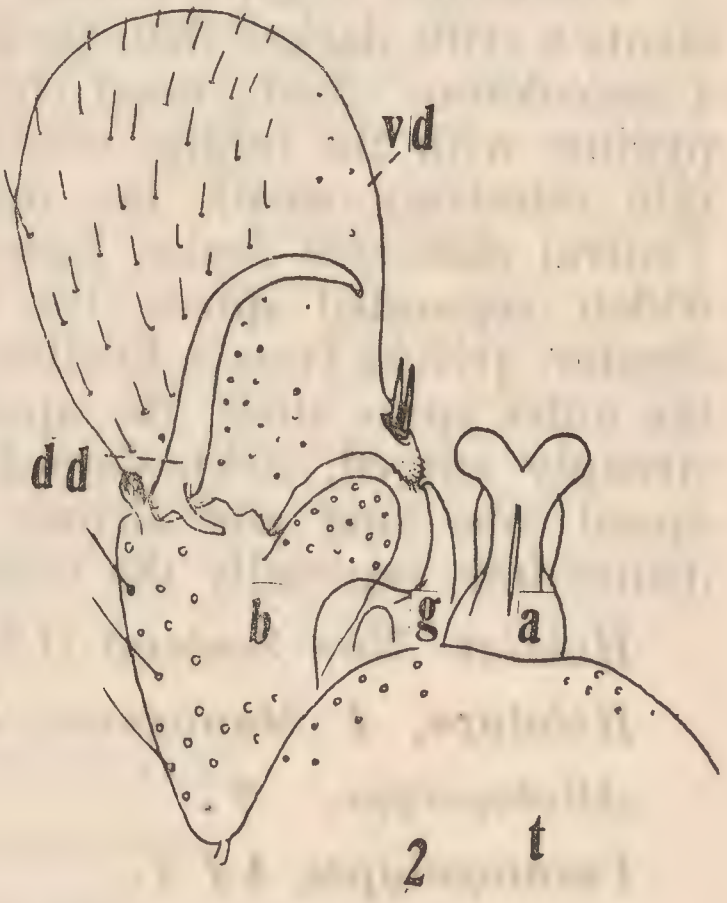
Dicranomyia lindsayi, sp. n.

Male.—Length about 7·5 mm.; wing 9·5 mm.

Female.—Length about 9 mm.; wing 9·8 mm.

Very closely related, and similar to *D. nebulifera* Alexander, differing in the structure of the male hypopygium.





1. Male hypopygium of *Dicranomyia nebulifera* (Alexander); dorsal aspect.

2. Male hypopygium of *D. lindsayi*, sp. n.; dorsal aspect.

The figures are drawn from flattened specimens.

a = aedeagus; b = basistyle; dd = dorsal dististyle; g = gonapophyse; t = ninth tergite; vd = ventral dististyle.

Halteres with the bases of the knobs slightly infuscated. Male hypopygium (fig 2) with the ninth tergite (t) relatively small, the caudal margin evenly rounded, the median area very slightly emarginate. Basistyles (b) relatively small, the mesal lobe large, setiferous. Ventral dististyle (vd) very large and fleshy, the setae small and reduced in size and number till almost lacking on the mesal face; rostrum relatively slender, the usual two spines short and spike-like, placed close together in a small common depression, not on elevated papillae. Dorsal dististyle (dd) broadest on basal half, the apex relatively slender, the extreme tip narrowed and decurved. Gonapophyses (g) with the mesal apical lobe relatively slender, narrowed to the small apex. Aedeagus (a) with apical divergent flaps.

Habitat—New Zealand (Chatham Islands).

Holotype, ♂, Mangere Island altitude 400 feet, *Jan.* 4–21. 1924 (Charles Lindsay).

Allotopotype, ♀.

This crane-fly is named in honour of the collector of the type-material, Mr. Charles Lindsay.

Dicranomyia gracilis Edwards.

1923 *Dicranomyia gracilis* Edwards, *Trans. N.Z. Inst.*, liv.; 283–284, pl. 27, fig. 25 (wing); pl. 32, fig. 133 (male hypopygium).

The commonest species in the collections. Numerous specimens from Mangere Island, altitude 400 feet, *Jan.* 4–21, 1924 (Charles Lindsay); Manukau Point, *Jan.* 1–2, 1924 (Charles Lindsay); Maunganui, *Dec.* 16, 1923 (Gilbert Archey).

Dicranomyia gracilis is very closely related to *D. monilicornis* (Hutton) but is probably distinct. The evidence at hand thus far indicates that it is a maritime species. Dr. Tillyard and Mr. Philpott found it in sea-caves at Nelson. Mr. Myers made the following interesting notes on the fly at York Bay, Wellington, November 25th, 1923:—"On seaward face of rocks almost surrounded by water—large numbers present, all bobbing up-and-down with such rapidity and vigour that the whole outline was misty. This they did immediately upon alighting, both sexes participating." The habit described is a very characteristic one for members of the tribe Limoniini.

Dicranomyia (Alexandriaria) conveniens Walker.

1848 *Limnobia conveniens* Walker; List Dipt. Brit. Mus., 1: 57.

1923 *Dicranomyia conveniens* Edwards; *Trans. N.Z. Inst.*, liv.: 282–283, pl. 27, fig 23 (wing); pl. 32, fig. 131 (male hypopygium).

One female, from Mangere Island, altitude 400 feet, *Jan.* 4–21, 1924 (Charles Lindsay).

Genus Discobola *Osten Sacken.*

Discobola chathamica, sp. n.

Allied to *D. picta* (Hutton); wings subhyaline with an abundant brown dotting in all the cells, the confluent dark areas in *picta* being broken into small spots and dots.

Male.—Length 7–7·5 mm.; wing 8–9·5 mm.

Rostrum and palpi brownish black. Antennae with the basal segment of the scape dark brown, the second segment obscure yellow; flagellar segments paler, almost yellowish, in some cases appearing weakly bicolorous. Anterior part of vertex between the eyes golden, the posterior part of the vertex grey with three velvety black areas, the median one only narrowly separated from the lateral or genal areas.

Pronotum pale, almost whitish, with a narrow black median line; praescutum pale, with a median pale brown stripe that is further split by a capillary black vitta; a conspicuous dark brown stripe extending from the head to above the wing-root, traversing the lateral margins of the pronotum and praescutum; posterior sclerites of mesonotum gradually darkening, the posterior portion of the postnotal mediotergite blackened, the base with a narrow silvery triangle. Pleura golden-yellow with a broad, conspicuous black stripe extending from the fore coxae across the ventral portion of the anepisternum, the pteropleurite, on to the postnotal pleurotergite, this being black except for the region adjoining the halteres. Halteres yellow, the knobs dark brown. Legs with the coxae largely dark brown, the bases indistinctly paler; trochanters brownish yellow; femora yellow with a conspicuous black subterminal ring at less than its length from the whitish apex; tibiae pale yellow, the tips scarcely darkened; tarsi yellow, the terminal three segments black. Wings subhyaline, with an abundant dark brown spotting and dotting in all the cells; apices of cells 2nd R_1 and R_2 faintly washed with brown; the usual massive dark areas at the origin of *Rs* and surrounding the stigma in members of the *venusta* group are here broken into disconnected spots and dots; the oblique clear band beyond the cord in *picta* is lacking, its location densely occupied with brown dots; the large dusky clouds at the margin in the cubital and anal fields in *picta* are here broken into small dots. Venation: Cell 1st M_2 irregular, as in *D. picta* and *D. striata;* supernumerary crossvein in cell 1st *A* transverse and relatively weak.

Abdomen dark brown, the hypopygium more reddish brown.

Habitat—New Zealand (Chatham Islands).

Holotype, ♂, Mangere Island, altitude 400 feet, *Jan.* 4–21, 1924 (Charles Lindsay).

Paratopotypes, 2 ♂ ♂; *paratype,* ♂, Kaingaroa, Chatham Island, *Dec.* 25, 1923 (Gilbert Archey).

The *venusta* group of the genus includes two described species with cell 1st M_2 irregular in outline, *D. picta* (Hutton) and *D. striata* Edwards. The Chatham Islands species above described is abundantly distinct from both of the above species.

Tribe Hexatomini.

Genus LIMNOPHILA Macquart.

Limnophila oliveri Alexander.

1923 *Limnophila oliveri* Alexander; *Ann. Mag. Nat. Hist.*, (9) xii.: 108–109.

One damaged male from Kaingaroa, Chatham Islands, *Dec.* 25, 1923 (Gilbert Archey). The fly had previously been taken only in the vicinity of Lake Wakatipu, Otago. A closely allied species (*L. indecora,* Alexander) occurs in Australia and Tasmania. It should be noted that these two flies are referred to the genus Limnophila only in its broadest sense.

Genus GYNOPLISTIA Westwood.

Gynoplistia chathamica, sp. n.

Nearly apterous, the wings (of the ♀ at least) shorter than the halteres, yellow; legs elongate, the tibiae longer than the tarsi; abdominal segments brown, the caudal margins of the segments buffy yellow.

Female.—Length about 17 mm.; wing 1·5 mm. Fore leg, femur, 8·5 mm.; tibia, 9·2 mm.; tarsus, 8·8 mm. Middle leg, femur, 9 mm.; tibia, 8·8 mm.; tarsus, 8 mm. Posterior leg, femur, 9·7 mm.; tibia, 10·5 mm.; tarsus, 8·3 mm.

Palpi dark brown, the segments short but distinct. Antennae with the scapal segments brownish yellow; flagellum broken. Head grey, the centre of the vertex weakly infuscated, with a yellowish pollen, the occiput reddish brown.

Pronotum large, brown, the posterior notum yellowish pollinose. Mesonotum depressed as usual in nearly apterous species, brownish yellow with indications of darker brown stripes; pseudosutural foveae large, reddish; posterior sclerites greyish. Pleura grey, the dorsal pleurites more yellowish; dorso-pleural membrane infuscated. Halteres obscure yellow, the knobs infuscated. Legs with the coxae and trochanters pale, the former sparsely whitish pruinose; legs long, giving the insect a spidery appearance, the tibiae longer than the tarsi in all cases, as shown by the above measurements; legs with conspicuous erect setae; femora obscure brownish yellow, the tip rather conspicuously infuscated; tibiae yellow, the extreme tip scarcely darkened, the long tibial spurs black; tarsi brownish yellow, the segments tipped with black. Wings small, shorter than the halteres, yellow throughout, the venation distorted.

Abdomen brown, the median area of the tergites darker brown, the caudal margins of the segments irregularly obscure

buffy yellow; tergites with an oblique line of shiny impressed dots on the posterior half of each sclerite; sternites more pruinose, the caudal margins of the segments similarly pale. Ovipositor with the valves straight, the extreme tips broken.

Habitat.—New Zealand (Chatham Islands).

Holotype, ♀, Wharekauri, among bush on hill, *Dec.* 13, 1923 (Gilbert Archey).

Gynoplistia chathamica is related to *G. ambulator* Alexander, *G. pedestris* Edwards, and *G. resecta* Edwards.

Tribe Eriopterini.

Genus Molophilus Curtis.

Molophilus, sp.

A female specimen of a medium-sized yellow species of this genus was taken at Maunganui, Chatham Islands, *Dec.*, 1923 (Gilbert Archey).

Genus Amphineurus Skuse.

Amphineurus hudsoni Edwards.

1923 *Amphineurus hudsoni* Edwards; *Trans. N.Z. Inst.* 54: 293, pl. 28, fig. 43 (wing); pl. 33, fig. 137 (male hypopygium).

A single female specimen from Maunganui, Chatham Islands, *Dec.*, 1923 (Gilbert Archey).

THE HEMIPTERA OF THE CHATHAM ISLANDS

By J. G. Myers, Wellington, N.Z.

The basis of this paper is afforded by a small collection made chiefly by Mr. C. Lindsay on the main island, (Rekohu or Chatham Island) and on Mangere Island in December, 1923, and January 1924. The list of species is as complete as it was possible to make it, and the writer believes that all previous records have been included. The first Hemiptera recorded from the islands of this group were sent with other insects "in a bottle of methylated spirits" to Hutton, who described them in 1898. Alfken, assisted by Kirkaldy, dealt with a much larger collection obtained by Schauinsland in 1896-1897. The present material, while containing fewer species than Schauinsland's collection, yet includes that great desideratum, several good series of specimens.

Of the Hemiptera fauna of the smaller islands in the New Zealand region extremely little is known. Even the closely adjacent and very extensive Stewart Island is a *terra incognita* to the student of this order, only one species of Hemiptera being so far recorded therefrom. From Stephen Island, a small islet in Cook Strait, remarkable in the possession of an endemic genus of birds (now extinct) and an endemic frog, and from the adjacent Trio Islands, through the kindness of Dr. R. J. Tillyard, the writer has received three species of Hemiptera, and Alfken has recorded two more from the former island. From Kapiti Island one or two cicadas are known from Andersen's (1923, p. 766) description of their songs. Cuvier Island, a tiny islet considerably east of Auckland, has yielded at least two species collected by the lighthouse-keeper, Mr. R. S. Sutherland. The more distant islands include the Subantarctic Islands in the far south, from which no Hemiptera have been taken in spite of Mr. Hudson's work there, the Kermadec Islands in the far north, from which, thanks to the energy of Mr. W. L. Wallace, the writer has now 13 species; and finally the Chatham Islands, which occupy an intermediate position some 500 miles east of Christchurch. Of all the island faunas then the Hemiptera of the Kermadecs are the best known. The amount of collecting still to be done on all the islands is tremendous, and will probably bring to light many interesting island races.

The number of species authentically recorded from the Chathams is eight. The Heteroptera include one Notonectid, two Lygaeids, one Aradid and one Pentatomid; while the Homoptera comprise a Cicadid, a Cercopid, and a Cicadellid. None of these

are endemic, and although the Chatham representatives may tend to vary in a definite direction, in only one case is the island form endemic.

The most interesting feature lies in the strong tendency to melanism in the Cicadid, the Cercopid, and the Pentatomid. Mr. Tonnoir (*in litt.*) writes that the same phenomenon is observable in the Lepidoptera. A general explanation is doubtless to be sought in the nature of the environment, but a plausible one is hard to find. Melanism in specific instances has been attributed to several different conditions. Thus Ford (1924, pp. 694–7, 702, 733, 740) in an exhaustive paper on the races of a Lycaenid butterfly, finds that in general a dark suffusion occurs in the warmest parts of the range and increases in intensity with temperature. Thus even in a given locality, the members of that brood which has experienced the most heat during the pre-adult stages, exhibit the darkest colouring. On p. 733, however, the same writer attributes suffused colouration to the influence of a moist habitat with luxuriant vegetation. The present writer has a specimen of *Melampsalta cruentata* from the very wet west coast of the South Island, which is almost as black as some of the darker of the Chatham forms. The climate of the Chathams is well known to be wet. Mr. Tonnoir (*in litt.*) suggests the influence of cold, stating that those individuals of the common drone fly (*Eristalis tenax*) which have developed from over-wintering larvæ are much darker than late summer specimens. These scattered examples are sufficient to show that no single condition can be definitely pointed out as a general factor in the production of melanism, or as an explanation of the tendency as it occurs in the insects of the Chathams.

Of the eight Hemiptera recorded from the Chathams, the distribution is as follows:—

Widespread through the Pacific (New Zealand, Hawaii, Tahiti, Philippines)—*Orthoea nigriceps.*

Australia, Tasmania, New Caledonia, New Zealand, Chatham Islands—*Aradus australis.*

New Zealand and Chatham Islands—*Anisops wakefieldi, Nysius huttoni, Rhopalimorpha obscura, Melampsalta cruentata, Cicadula awae, Philaenus trimaculatus trimaculatus, P. t. tristis.* (All except *Cicadula awae* are known to be widely spread over the North and South Islands, and *R. obscura* extends also to Stewart Island).

Chatham Islands only—*P. t. laetus.*

The Chatham Islands consist of two large islands and a considerable number of smaller ones, the faunas of which exhibit considerable endemism. As might be expected, most of the Hemiptera recorded from the Chathams were collected on the main island (Rekohu), but a few have been taken on Pitt Island and from Mangere Island. Alfken (1904) incorrectly included Pitt Island among the New Zealand mainland localities. The rectification of this error does not, however, augment the Chathams list. Pitt Island, which is still, according to Mr. C. Lindsay, more than half under heavy primitive forest, would probably richly repay future collectors. Mangere Island, a small block lying off the coast of Pitt Island, is remarkable as the only home of now extinct Ralline genus *Cabalus*. As its forest is now almost entirely gone, and the island heavily stocked with sheep, it is unlikely that the results of Mr. Lindsay's three week's stay will be materially supplemented by future collecting. There is a tragedy about the vulnerability of these small and interesting islands which should impel future visitors to collect as comprehensively as possible while there is yet time.

Hutton does not mention definite localities in the Chatham Islands. Alfken's specimens apparently all came from the mainland, except some *Melampsalta cruentata* from Pitt Island. In the present collection Mr. Lindsay has been most meticulously careful in giving exact localities. There are specimens of *M. cruentata* from no fewer than six main island (Rekohu) stations, and from Mangere Island. The *Cicadula* is from Rekohu, as is also the series of *Philaenus trimaculatus* in all three varietal forms.

Of the ecology of the Chathams Hemiptera little can yet be said. On the mainland of New Zealand, however, the eight species recorded from the Chathams occupy the following stations; it is probable that their ecological status on the Chatham Islands is not markedly different:—

Aquatic (fresh water)—*Anisops wakefieldi.*

Low herbage—in open country (swamp, heath, arable land or pasture)—*Orthoea nigriceps, Nysius huttoni, Rhopalimorpha obscura, Melampsalta cruentata, Cicadula awae, Philaenus trimaculatus* (sometimes in undergrowth of forest, especially near outskirts).

Beneath bark, but usually widespread and casual in distribution—*Aradus australis.*

There is thus a paucity of forest-dwelling species; the absence of all the common bush-frequenting cicadas (*Melampsalta*

cingulata, M. cauta, M. muta, M. subalpine, M. scutellaris) being especially remarkable.

For the privilege of examining the present collection made by Messrs. Archey and Lindsay, the writer is indebted to the Canterbury Muesum authorities, and especially to Mr. A. L. Tonnoir, Assistant Curator.

In the citations of Alfken's paper (1904) it should be remembered that most if not all of the Hemiptera were determined by Kirkaldy. Alfken himself apparently described the two colour-varieties of *Philaenus trimaculatus*. Kirkaldy (1909, pp. 24–28) in listing the Hemiptera of the New Zealand region includes the Chatham Islands records published by Alfken five years previously; but as Kirkaldy adds practically no new matter his citations have not always been repeated in the present paper. Under the species unless otherwise stated, references only to Chatham Islands records are given.

SUB-ORDER HETEROPTERA.

FAMILY NOTONECTIDAE.

1. **Anisops wakefieldi**, F.B.W.

Alfken, 1904, *Zool. Jahrb. Syst.*, 19, p. 599.

Only one example was taken, and this was compared by Kirkaldy with the type in the British Museum. The other species, *A. assimilis* F.B.W., is on the mainland far and away more plentiful. In view of the general melanic tendency in Chathams *Hemiptera* it is interesting to note that *A. wakefieldi* is often much darker, with a black scutellum, while *A. assimilis* is typically wholly pale.

FAMILY LYGAEIDAE.

2. **Nysius huttoni** F.B.W.

Alfken, 1904, *Zool. Jahrb. Syst.*, 19, p. 599.

Only one specimen recorded.

3. **Orthoea nigriceps** Mayr.

Alfken, 1904, *Zool. Jahrb. Syst.*, 19, p. 599.

The single specimen taken was compared with the type in the British Museum, and considered by Kirkaldy to belong to the var. *inornata* (Walk).

FAMILY ARADIDAE.

4. **Aradus australis** Erichs.

Alfken, 1904, *Zool. Jahrb. Syst.*, 19, p. 599.

Only one specimen taken.

FAMILY PENTATOMIDAE.

5. **Rhopalimorpha obscura** White.

Alfken, 1904, *Zool. Jahrb. Syst.*, 19, p. 599.

Rhopalimorpha ignota Hutton.

1898, *Trans. N.Z. Inst.*, vol. 30, p. 159.

1909, Kirkaldy, *Trans. N.Z. Inst.*, vol. 41, p. 24.

No specimens of this pentatomid were collected by Messrs. Archey and Lindsay. Of the example taken by Schauinsland, Kirkaldy (quoted by Alfken) wrote, "Da, auf den Chatham—Inseln gesammelte Exemplar ist die echte *R. Obscura* und nicht die Varietät? *R. ignota* Hutt." In the Canterbury Museum is the single type specimen of *R. ignota*, together with a closely similar example from Whangarei, North Island of New Zealand. Thus *R. ignota* is neither endemic in the Chathams nor is it the only form there present.

The status of this alleged species now remains to be considered. The type and the accompanying Whangarei specimen, both recently lent me through the courtesy of Mr. Tonnoir, are rather dark in colour, but that appears to be practically the only distinction. Hutton (1898, p. 159) writes: "without any smooth band on the head and pronotum," and makes this the chief, if not the only difference between *R. ignota* and *R. obscura*. Yet in the type itself this smooth pale band is discernible at least on the pronotum, with the naked eye. Dark coloured specimens are quite plentiful on the mainland, and the pale longitudinal smooth band is frequently almost obsolete anteriorly. The use of methylated spirits as a preservative may well have darkened the Chatham Island specimen on which Hutton founded his species, but even in its present state it is no darker than several mainland examples. The writer is of the firm opinion that *R. ignota* is admissible not even as a constant colour variety. The species is well known to be variable in colour—two individuals seldom agree in this character. Kirkaldy, quoted by Alfken, wrote concerning R. obscura, "Ich habe von dieser Art 10, Expl. untersucht, und ich muss nach der Veränderlichkeit

derselben annehmen, dass die 3 Arten, *R. obscura* White, *similis* Mayr, und *ignota* Hutt. identisch sind.''

After examining some hundreds of specimens from widely separated localities the present writer feels sure that there is only one species, and that this is surprisingly constant in structural characters. Hutton himself omits *R. ignota* from his *Index Faunae* (1904).

Kirkaldy, in his later work (1909, p. 24) incorrectly cites Dallas as the author of *R. obscura.* Dallas (1851, p. 293) actually quoted in inverted commas, Adam White's manuscript and credited the description to the latter, thus giving standing to White's name.

SUB-ORDER HOMOPTERA.

FAMILY CICADIDAE.

6. **Melampsalta cruentata** Fabr.

Melampsalta cruentata, Fabricius.
Hutton, 1898, *Trans. N.Z. Inst.*, vol. 30, p. 160.
Myers, 1921, *Trans. N.Z. Inst.*, vol. 53, p. 250.

''*Cicadetta cruentata,* F. nebst der var. *muta* F....Pitt Is.''
Alfken, 1904, *Zool. Jahrb. Syst.*, 19, p. 582.

''*C. cruentata* Fabr. und die Varietät *muta* Fabr..... Beide häufig.''
Alfken, 1904, l. c., p. 598.

''*Cicadelta muta,* Fabricius (var. *subalpina,* Hudson).''
Kirkaldy, 1909, *Trans. N.Z. Inst.*, vol. 41, p. 27.

''*C. cruentata,* Fabricius.''
Kirkaldy 1909, l. c., p. 28.

Taxonomic reference: Myers, 1921, *Trans. N.Z. Inst.*, vol. 53, p. 244.

There are three records of *Melampsalta cruentata,* the commonest *cicada* in New Zealand, occurring in the Chatham Islands. Messrs. Archey and Lindsay now add a fourth, supported by a beautifully authenticated series. A few notes on this collection will be made before the synonymy set forth above is discussed and justified. The cicadas collected by the recent expedition are included in the following nine lots:—

(Chatham Island, or Rekohu is the main island of the group.)

A. 14 very constant males, strongly suffused with black; 2 females, one pale greenish and the other fawn—Maunganui, Chatham Island, *Dec.*, C. Lindsay.

B. 4 dark males from Wharekauri, Chatham Island, *Dec.*, C. Lindsay.

C. 2 dark males and 2 females, pale green and pale fawn respectively, from Kaingaroa, Chatham Island, *Dec.*, C. Lindsay.

D. 2 dark males and 3 pale green females, from Waiparua, Chatham Island, *Jan.*, C. Lindsay.

E. 5 dark males and 2 pale green females, from Whangamarina, Chatham Island, *Jan.*, C. Lindsay.

F. 2 dark males, and 1 small brownish-fawn female, from the Ngaio, Chatham Island, *Jan.*, C. Lindsay.

G. 3 dark males from Chatham Island, *Dec.–Jan.*, G. Archey.

H. 8 extremely dark males from Mangere Island, *Jan.*, C. Lindsay.

I. 1 female nymph near last ecdysis, Kaingaroa, *Dec.*, C. Lindsay; 1 female cast nymph skin, Maunganui, *Dec.*, C. Lindsay; 1 male cast nymph skin, Maunganui, *Dec.*, C. Lindsay; 1 male ultimate nymph, Kaingaroa, *Dec.*, C. Lindsay.

Of the forty males all are darker than the average mainland form, while some, especially those from Mangere Island, are almost black. Nearly all the Mangere specimens are consistently darker than those from the chief island (Chatham or Rekohu). The six specimens recorded by Hutton in 1898 and examined in the Hutton collection by the writer (1921, p. 250), are also very melanic, and agree well with lots A–G in the above inventory. The males on the whole present a very uniform appearance, varying chiefly if at all, in the amount and intensity of the dark markings, though not so much as would a random collection of the same extent made in the vicinity of Wellington (mainland, North Island). No other feature than the greater average intensity of the dark markings is apparent to separate the Chatham Islands form from typical mainland examples. Moreover, a male almost as dark is in the writer's collection from the West coast, South Island (mainland).

The females differ in no respect whatever from the typical mainland form. *M. cruentata* is by far the most strongly sexually dimorphic of the New Zealand *cicadas,* and the female is usually much more procryptically coloured than the males; pale greens are the most frequent, and fawns. Such colouration, combined with the pale stripe along the dorsum, serves to render the female very difficult to distinguish among the grasses on which it rests. Among the Chathams specimens it is noteworthy

that the strong melanic tendency seems entirely confined to the male sex. Thus the female is coloured just as procryptically as on the mainland, while the male is almost certainly rendered more conspicuous.

The genitalia of these dark Chatham males differs in a few minor details from those of the typical form. The aedeagus appears slightly longer with the tip of the main lobe more pointed and rather more deeply incised, while the copulatory hooks (genital styles?) exhibit a slight difference in shape. Until work now in progress on the genitalia of all the New Zealand species is completed and a large series of mainland examples examined in this particular, the writer is unwilling to separate the Chatham form even subspecifically. The gradations between the darkest Mangare Island form and the palest mainland example are numerous and fine.

Turning now to the question of synonymy, as set out under the name of this species, the writer believes that all the cicadas so far collected in the Chathams are referable to *M. cruentata* (Fabr.).

In Alfken's paper, Kirkaldy wrote, "Ich kann zwischen *Cicadetta* (= *Melampsalta*) *cruentata* und *muta* keine Verschiedenheit in der Struktur ausfinden machen, und, so viel ich weiss, hat bischer noch kein Autor eine solche erwähnt. Es scheint mir, das sich alle von Neuseeland beschreibenen *Cicadetta*—Arten auf 5: 1 *cruentata* Fabr. (enthält die *muta* Fabr. u.s.w.) 2 *nervosa* Walk., 3 *iolanthe* Huds., und 5 *cingulata* Fabr. reduciren lassen. Vielleicht sind auch 2 und 3 nur die Varietäten von 1" (Alfken, 1 c. p. 582). But in 1909 (p. 28) Kirkaldy wrote, "My remarks cited by Alfken.....were written in 1899, and are to be disregarded entirely, as I had not then studied the genitalia." The implication is that Kirkaldy's findings in 1909, when he changed his Chatham records to *muta* var. *subalpina* and *cruentata*, were based on a study of the genitalia. Variety *subalpina* of Hudson was described under *muta* Huds., (= *cruentata* (Fabr.)), but it seems certain to the present writer that *subalpina* is a variety of neither species, but is itself entitled to specific rank. In lot D of the above list are two females of *M. cruentata* typically coloured, but considerably larger than the average. Such large forms are by no means rare on the mainland, and the point of importance is that these agree in coloration and superficial appearance with *subalpina*. The writer believes that the one or more examples identified by Kirkaldy as *subalpina* were really referable to these large female forms of *M. cruentata*. Thus Alfken described both *M. cruentata* and "die Varietät *muta*" (= *muta* var. *subalpina*,

Kirkaldy, 1909) as "beide häufig." This would apply well to the two sexes of the same species; but if *subalpina* were really "häufig" in the Chathams, it is remarkable that Mr. Lindsay saw no specimens during his two months' collecting, in which period his extensive series show that he must have paid considerable attention to *Cicadidae*.

Mr. C. Lindsay states that many of the cicadas from Maunganui (Rekohu) were taken on marram grass, *Ammophila arenaria* (L.) Link on the sand hills.

FAMILY CERCOPIDAE.

7. **Philaenus trimaculatus** White.

Alfken, 1904, *Zool. Jahrb. Syst.*, 19, p. 598 (*Ptyelus*).
Kirkaldy, 1909, *Trans. N.Z. Inst.*, vol. 41, p. 28.
Hutton, 1898, *Trans. N.Z Inst,* vol. 30, p. 160.

This common and widespread New Zealand froghopper seems equally plentiful on the chief island of the Chathams group, viz., Chatham Island or Rekohu. The writer has little to add to Alfken's remarks on this species. Dissection of the male internal genitalia shows that the diverse forms are rightly treated by Alfken as "Farben-varietäten" only. The whole species is evidently in a plastic condition, exhibiting inconstant variation even in the genitalia. Thus figs. 1–3 show genital styles of two practically identical examples of the type form from mainland and of a specimen of the var. *laetus* (Alfken) from Chathams. The forms present on the Chathams may be separated as follows, though as pointed out by Alfken himself, numerous intermediates exist.

A. *P. trimaculatus trimaculatus* (Butl.). Figs. 1, 2, 4.

Tegmen dark with a very narrow, pale outer (costal) border, and three yellowish white spots as follows:—

(*a*) A broad band running obliquely from scutellum to middle of costal border. This is usually strongly marked.

(*b*) A more or less triangular patch with its broad base on the claval margin and its apex at the middle of the surface of tegmen. This is the first pale spot to disappear when melanism develops.

(*c*) An oval spot on the costal border near the tip. This is always the whitest and most clearly defined mark, and is the last to vanish.

Alfken recorded this, the type-form, from the Chatham Islands, but the writer has seen no entirely typical specimens from that locality. Those which agree in the markings differ from the average mainland forms by the intensity of their dark coloration, and by the more pronounced production of the vertex. Both these characters are present in all the Cercopid material from the Chathams. The examples which come nearest to *P. t. trimaculatus* in tegmen colour-scheme comprise 2 males and 4 females from Maunganui (Chatham Island, C. Lindsay, 16/12/23), and 1 female from the Ngaio (Chatham Island, C. Lindsay, 24/1/24).

B. *P. trimaculatus laetus* (Alfken). Figs. 3, 5.

The following is a free translation of Alfken's description:— The lightest specimens are yellow with a dark spot on the shoulder and another at the apical angle of the suture; these spots are connected by an S-shaped ribbon. This constitutes the variety *laetus*.

To correlate this description with that of the type form it must be recognised that of the three pale spots, *a* has widened to cover much of the basal half of tegmen; *b* is little larger, though widened at base, but is sharply defined, filling one of the curves of the S-shaped ribbon; while *c* differs but little from the corresponding spot in the type. It will thus be seen that little more than an increase in one of the pale spots has produced a very different looking insect. *P. t. laetus* in fact is at first sight remarkably distinct. The dark areas of this variety, as of all the Chatham Island specimens of *Philaenus* are usually much more intense than those of typical examples from the mainland, so that Alfken is perhaps hardly correct in calling it the palest form. It seems probable, however, that Alfken's type of *laetus* had more extensive pale areas than any specimens in the present collection.

The genitalia of the male (fig. 3) differ in no constant characters from those of *P. t. trimaculatus* collected on the mainland (figs. 1, 2). The mainland form varies somewhat in the shape of the genital style, and the male *laetus* dissected occupies a somewhat intermediate position in this respect. Unfortunately only three males were present among the Chathams Cercopid material, and extensive comparisons were impossible.

Intermediates in colour, between *laetus* and the two other forms are plentiful—in fact hardly two froghoppers among the Chathams examples are alike. The Chathams collection includes four specimens of this colour variety all differing in the extent of the pale markings. The three females are more like Alfken's

description, while the male has spots *a* and *b* confluent. All four are from Maunganui, Chatham Island (C. Lindsay, 16/12/23). No form which can be referred to var. *laetus* has yet been collected on the mainland.

C. *P. trimaculatus tristis* (Alfken), Fig. 6.

The following is a free translation of Alfken's description:— In the darkest specimens only the light-coloured outer edging and the oval spot near it are present. This is named the variety *tristis.*

In this form, spots *a* and *b* have completely disappeared. The ground colour is almost black, and in some forms even *c* shows a tendency to decrease in size, till in one specimen from the mainland of North Island (Ohakune, forest, 2,100 ft.) it is almost invisible on one tegmen, only the outline being visible, while on the other tegmen the spot is moderately distinct. In the Chathams collection only one specimen (a female from Manukau, Chatham Island (C. Lindsay, 2/1/24) agrees fully with the description, but three other females, with a vestige of spot *a* though intermediate, should really be placed here. Of these one was caught at Manukau (C. Lindsay, 2/1/24), while the other two were secured at Maunganui (C. Lindsay, 12/12/23).

It has been already mentioned that an example even darker than Alfken's *tristis* has been taken on the mainland. Also a form agreeing exactly with *tristis* has occurred on the mainland, at Kaitaia. This latter is a male, while all the Chatham specimens of *tristis* are females.

To sum up, it seems that *Philaenus trimaculatus* is an exceedingly variable species, divided, so far as the colour-scheme is concerned, into three main varieties connected, especially on the Chathams, by numerous intermediate forms. The species is also slightly variable in the shape of the male genital style, but the variation in this organ is not correlated with the variation in the colour-scheme. The three forms found on the Chatham Islands, in spite of wide divergences from one another in scheme of coloration, are distinguished from the type as figured by White (in Butler, 1875, pl. 7, f. 10), and commonly collected on the mainland, by the following common characters—the dark areas however decreased or extended are usually much darker, and the head (vertex) is rather more strongly produced.

The var. *tristis,* whether on the mainland or on the Chatham Islands is moderately constant in these two characters.

All the Cercopids collected by Mr. Lindsay, and apparently all those previously taken at the Chathams were collected on the chief island (Chatham Island or Rekohu). The collection contains 2 advanced nymphs probably referable to this species. They are pinned specimens much shrivelled.

The author's name to be cited for this species is (White). In 1846 White described and figured it as *Aphrophora trimaculata* in his manuscript on the insects of the *Erebus* and *Terror* voyage. This was cited by Walker in 1850 (p. 718) as though from a published work, but without description. Kirkaldy (1909) and Alfken (1904) are, therefore, incorrect in citing Walker as the author. The account of the *Erebus* and *Terror* insects was finally published in 1875, with the prefaced statement that pp. 1–24 were by Adam White, and pp. 25–51 were the work of A. G. Butler. All the Hemiptera are described in Butler's pages, but that author refers to White's manuscript and publishes White's figures at the end of the volume; therefore White should be cited as the author of the species.

FAMILY CICADELLIDAE (Jassoidea).

Sub-family: *Thamnotettiginae* (Thamnotettigidae Baker).

8. **Cicadula awae*** Myers, n. sp., figs. 7–13.

Male—Length, 4 mm. (to tip of folded tegmen).

Fairly elongate. Vertex slightly longer at middle than near eye; only about one and a half times as wide as long. Pronotum broadly convex anteriorly, practically straight posteriorly. Tegmina reaching considerably beyond tip of abdomen.

Colour bright canary yellow; eyes dark brown. Vertex with two irregular, tranverse, parallel black stripes and caudad of these a pair of black spots. Pronotum with a short, black interrupted transverse line near anterior border and a few dots on disc; two black spots on each side. Scutellum with two black spots near anterior margin and caudad of these two more united mesally into a horse-shoe with convexity cephalad. Tegmina with veins widely yellow bordered with smoky brown. Face with sutures, arcs on frons and a thick median longitudinal line on clypeus, black. Legs yellow, with longitudinal lines, bases of tibial spines, and apical parts of tarsal segments black.

Genital valve small, blackish, much wider than long, widely rounded caudally. Plates large, triangular, yellowish tipped

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* *Awa in Maori* = stream or Gully, damp hollow or depression. (Mr. Elsdon Best.)

with blackish bristling with pale hairs and extending practically to end of abdomen. Style with a moderate anterior process. Connective Y-shaped with stem widening distally. Aedeagus long, fairly stout, with a somewhat collar-like membranous dilatation about half way, and a swollen, rounded apex with at least two hooks directed cephalad.

Female—Length, 4·2 mm. (to tip of folded tegmen).

More elongate. Colour paler and decidedly greenish.

Posterior border of last ventral segment emarginate, with two slight rounded processes medially. Ovipositor equal in length to the "pygofers" (of Osborn and Lawson). Pygofers yellow with stout black bristles abundant apically.

Holotype, Allotype—In swampy hollow, Southdown, Auckland, 8th February, 1924, in coll. J. G. Myers.

Described from 24 males and 36 females taken at the type locality on the same date, and from two males collected by C. Lindsay, 25th December, 1923, at Kaingaroa, Chatham Island (Rekohu). Unfortunately the Chatham Island specimens are transfixed by large pins already heavily coated with verdigris, and are almost unrecognisable. They appear somewhat paler and duller in colour than the mainland males.

This leafhopper seems quite a typical member of the widespread genus *Cicadula* Zett. The male genitalia resemble somewhat those of *C. sexnotata* (Fallen) as figured by Lawson (1920, Pl. 15 fig 6).

The present species is evidently one of those swamp-haunting forms which a consideration of Chatham Island topography indicates as probably abundant there.

The writer's material was collected by sweeping in a pasture containing a few boggy basins between volcanic rock outcrops. The leafhoppers were confined to the hollows, where they were exceedingly abundant. The moisture of these depressions maintained a luxuriant growth of grasses and other plants, in striking contrast to the drought conditions which prevailed in the surrounding country. The vegetation consisted of a dense carpet of *Bulbilis dactyloides* (Nutt.) Raf. (buffalo-grass) replaced in the wetter parts by a deep green sward of *Juncus lampocarpus* Ehr., both sometimes tangled with *Lotus major* Sm. *Polygonum Persicaria* Linn, *spharganium subglobosum* Morong, and *Cyperus sp.* were also present.* The leafhoppers did not seem to be restricted to any one plant-species in this complex.

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* The writer is indebted to Mr. Esmond Atkinson, Botanist to the Department of Agriculture, for the identification of most of these plants.

Adult hoppers were most numerous, but nymphs of apparently the ultimate and penultimate instars were also present.

Advanced nymph—Length 3 mm.

Form markedly elongate. Colour dark olive marked with piceous (female), or almost entirely pitchy with a few olivaceous marks on vertex, nota and a median longitudinal dorsal line (male). Head rather more pronounced than in adult; width of head, including eyes, considerably greater than the width anywhere else. A somewhat paler line edged with blackish extends from fore border of vertex without interruption to tip of abdomen. Tegminal pads extending just past the level of second apparent dorsal segment of abdomen. Abdomen strongly terete in dorsal view; beneath flattened or concave. Ventral surface black with a large yellow spot on the tucked under part of every tergite.

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EXPLANATION OF FIGURES (Plate xxxiii).

Fig. 1—*Philaenus trimaculatus* (White), type var., right genital style of male.

„ 2—*Philaenus trimaculatus* (White), type var., right genital style of male.

„ 3—*Philaenus trimaculatus* (White), var. *laetus* (Alfken).

„ 4— „ „ type var., right tegmen.

„ 5— „ „ var. *laetus* (Alfken), right tegmen.

„ 6— „ „ var. *tristis* (Alfken), right tegmen

„ 7—*Cicadula, awae,* left wing.

„ 8— „ „ left tegmen.

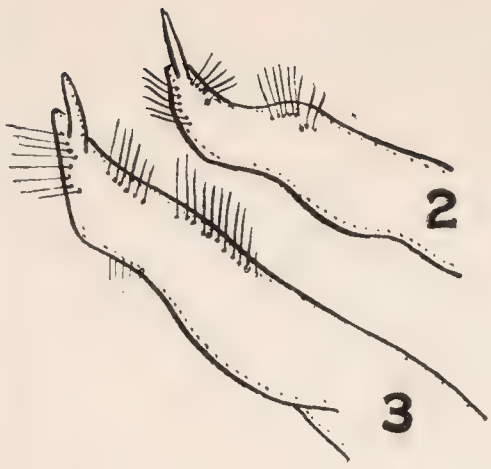
„ 9— „ „ head, pronotum and scutellum, dorsal view.

„ 10— „ „ male genitalia, lateral view.

„ 11— „ „ male genitalia, styles, connective, and aedeagus.

„ 12— „ „ male genitalia, tip of aedeagus.

„ 13— „ „ face of male.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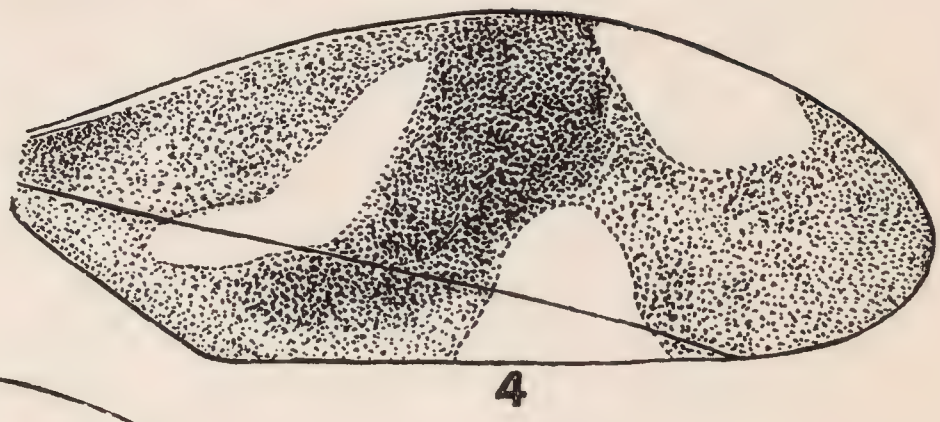
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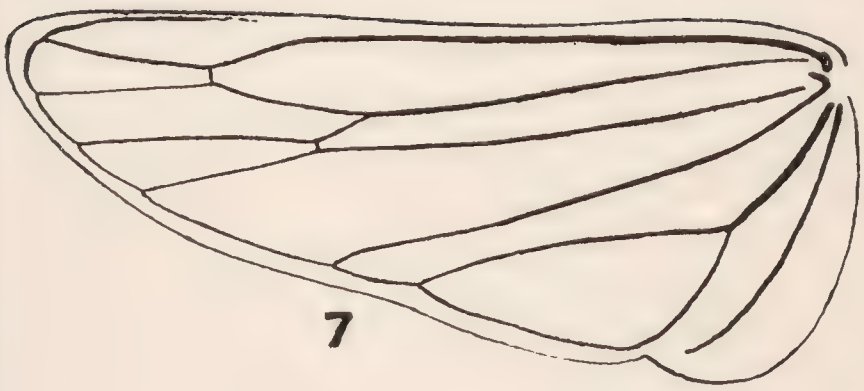
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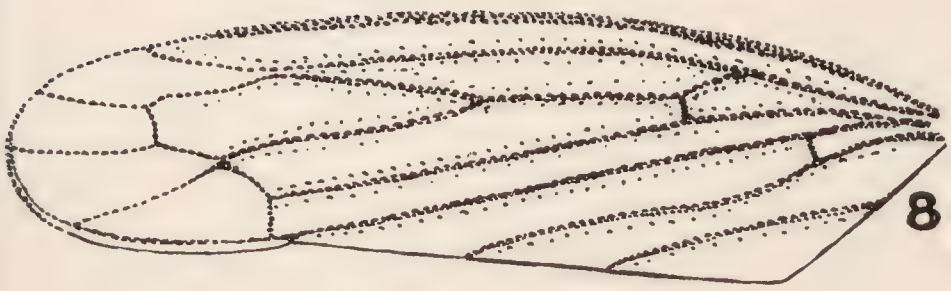
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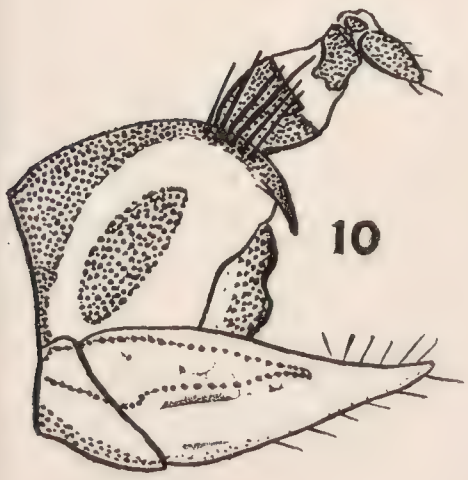
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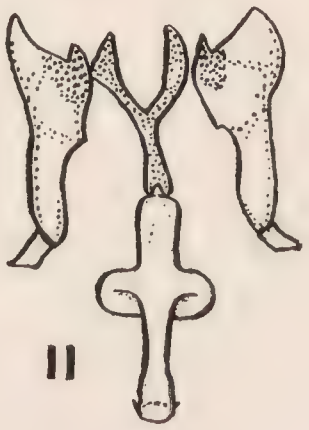
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NOTES ON THE BIRDS OF THE CHATHAM ISLANDS

By Gilbert Archey, Assistant Curator*; assisted by Charles Lindsay, Junior Assistant.†

It is now over thirty years since Dr. H. O. Forbes published his account of the "Birds inhabiting the Chatham Islands," in *The Ibis* for October, 1893, and although notes on several of the birds have since appeared, chiefly in the writings of Buller and Rothschild, Forbes's paper remains up to the present the last complete report on the avi-fauna of these islands.

The writers of the present notes are pleased to be able to submit their observations made during a two months' stay in the islands during December and January last; but they regret that, through adverse weather conditions, they were unable to gain access to certain small islets, which may possibly still shelter a few of the birds which have not been definitely reported for many years.

Most of the land birds inhabiting the Chatham Islands were, however, observed, and by kind permission of the Hon. the Minister for Internal Affairs, a limited number of several species was secured for examination.

On the whole we are able to report that the reduction in numbers of not a few species, the commencement of which was recorded by Forbes, and its continuation noted by Buller and Rothschild, has been definitely reversed, and species whose extinction was once feared, are now present in satisfactorily increasing, if not yet abundant, numbers. In several instances we have had the benefit of the observations of residents of long standing, keen students of the native birds and their ways, and for these observations, as well as for their most generous hospitality and practical assistance, we desire to thank many kind friends.

In the detailed account following, the reference has been given in each case to Forbes's paper in *The Ibis* for October, 1893, pp. 521-546, pls. 14 and 15.

1. **Eudyptula minor** (Forster).

[55] *Eudyptula minor*. Forbes, p. 543.

The Blue Penguin breeds plentifully around the coasts, and is found in run-ways among the marram grass on the sandhills, or under ledges of the rocky bluffs. It occurred, however, in the greatest numbers on a steep slope, strewn with huge rocks, and sparsely covered with trees, on the eastern side of Mangere

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† Now Taxidermist in charge Newtown Museum, Wellington.

Island, where there must have been many hundreds of birds in the extensive tunnels under rocks and among the roots of the trees. Breeding was practically over, for only a few late down stages were obtained, and the adult birds were in various stages of moult. On the peaty uplands in other parts of Mangere Island the penguins were found competing with the mutton-birds (*Puffinus griseus*) for tenancy of the burrows, even to the highest part of the narrow tableland, 900 feet high. Here the penguins were all moulting, and it seems unlikely that they breed so high up, for the plateau can be gained only by a journey of over a mile up steep slopes. Quarrels between penguins and petrels for possession of the burrows were both frequent and noisy: sometimes the penguin was driven out, at other times the petrel was evicted; but on the lower slopes, where the soil is penetrated by an extensive system of intercommunicating tunnels, and, apparently, more give and take possible, the sounds of quarrelling were heard less frequently.

We have quoted this species as *E. minor,* as we are unable to follow the distinction between *E. minor minor* and *E. m. iredalei* Mathews. The type of the latter has culmen 34 mm., depth of bill 16 mm., which clearly distinguishes it from *E. m. novaehollandiæ* Stevens from Australia (Mathews, *Birds of Australia*, vol. 1, p. 283). The bills of our Chatham Islands adults measure, culmen 35 to 37 mm., depth of bill 17 to 18 mm., but as measurements from known New Zealand specimens vary from 30 to 40 mm. culmen, and 14 to 17 mm. depth of bill, we do not seem to have here a sufficient character to separate the two forms. As we have had only faded exhibition specimens for comparison, we do not comment on the darker coloration of *E. m. iredalei* except to suggest seasonal change, or possible loss of intensity in the colour between moults.

Eudyptes pachyrhynchus Gray.

[54] *Eudyptes pachyrhynchus.* Forbes, p. 543.

Forbes lists the Crested Penguin, but makes no observations with regard to it. I can find no record of its breeding on the Chatham Islands, neither does any resident know of its doing so, the few specimens seen at different times being visitors, probably from the Snares; or they might have been *E. sclateri* from the Bounty Islands.

2. **Garrodia nereis** (Gould).

Grey-backed Storm Petrel.

[51] *Garrodia nereis.* Forbes, p. 542, pl. 14, fig. 3, egg.

3. **Pelagodroma marina** (Latham).

WHITE-FACED STORM PETREL.

[50] *Pelagodroma marina.* Forbes, p. 542.

Both these Storm Petrels are said to breed on South-east Island, which we were, however, unable to visit. On Mangere Island we found mutilated remains of *P. marina.*

4. **Puffinus griseus** (Gmelin).

MUTTON-BIRD.

[49] *Puffinus griseus.* Forbes, p. 542.

Every peat-covered headland on the main island and on Mangere Island was a Mutton-Bird warren. Eggs in various stages of incubation were found during December and the first fortnight of January, and it was not until the 15th of the latter month that hatching took place, at least on Mangere Island. At Maunganui, in the north-west of the main island, the mutton-birds have occupied a long deep fissure, which runs for a considerable distance into the base of the hill. Here the egg is laid on the flat sandy floor of the cave, close against the rocky wall. It is considered by the residents that the South Island Weka (*Gallirallus australis*), introduced in 1905 and now extremely abundant, invades the burrows during the daily absence of the parent birds, and destroys the young, but there is no direct evidence of this.

5. **Pterodroma cookii axillaris** (Salvin).

CHATHAM ISLAND PETREL.

[47] *Oestrelata axillaris.* Forbes, p. 542.

No specimens were secured, but Mr. H. G. Blyth, of the Tuku station, states that it breeds in deep tunnels among the roots of trees on the cliffs of the south-west portion of the main island, near to the two sharp volcanic cones, known as The Horns.

6. **Pachyptila turtur** (Kuhl). [45].

CHATHAM ISLAND DOVE PETREL.

[45] *Prion turtur.* Forbes, p. 542.

This whale bird breeds on Mangere Island, where it is numerous in spite of the toll levied by cats. The nestlings in the narrow burrows are probably fairly safe from direct harm; but the numerous pairs of wings found lying about indicate the considerable destruction effected by the cats. We noticed that the long grass on the slopes hindered the whale birds from taking

flight quickly, a long fluttering dash through the grass being a necessary preliminary: a fatal handicap to a bird trying to escape from its pursuer.

At the beginning of January, when we landed on Mangere, the nestlings were half grown, being covered with a long bluish-grey down, shorter on the head, which was usually tucked back into the neck-down. By the middle of the month they were nearly full-grown and part fledged, *i.e.*, the wing primaries and secondaries, and a few of the coverts had appeared. The bill was relatively soft, and slenderer than in the adult. In the adult some variation in the bill was noted, both in the width of the bill and the relative size of the "nail," to the extent that we found it difficult to decide whether they represented the large-nailed broad billed condition of *Pseudoprion* or the small nailed narrow billed condition of *Heteroprion*. Another condition noted was that in the wing, instead of the first primary being the longest, it was sometimes equal to the second or even shorter than it.

7. **Pachyptila vittata** (Gmelin).

BROAD-BILLED PRION.

[46] *Prion vittatus.* Forbes, p. 542.

Wings and bills of this bird lying about on Mangere Island showed that it also suffers from attacks by cats. It breeds earlier than the previous species, and all the young ones had left before we visited the island. The eastern slope, near to the penguin burrows mentioned above, is its particular home, and, as reported by Mr. George Clough, the headland of Pitt Island, immediately opposite to Mangere, is also a breeding place.

8. **Macronectes giganteus** (Gmelin).

[48] *Ossifraga gigantea.* Forbes, p. 542.

Giant Petrels were frequently seen off Mangere Island, but we have no definite knowledge of their breeding on the Chatham Islands.

9. **Pelecanoides urinatrix** (Gmelin).

[43] *Pelecanoides urinatrix.* Forbes, p. 541.

[44] *P. berardi.* Forbes, p. 542.

The Diving Petrel was not seen, but Mr. H. Clough and Mr. T. McClurg state that it still breeds on South-east Island.

10. **Diomedia epomophora** Lesson.

[41] ? *Diomedia exulans.* Forbes, p. 541.

Albatrosses breed on the "Forty-fours," and from a sun-dried skin examined, as well as from several descriptions of the "white-headed" young, we have no doubt that they are the Royal Albatross and not *D. exulans* as recorded by Forbes, and later mentioned (with a query) by Mathews and Iredale.*

11. **Diomedia melanophrys** Temminck and Langier.

[42] *Diomedia melanophrys.* Forbes, p. 541.

This bird is listed by Forbes, and Mollymawks certainly breed on the outlying islands, but we could not observe any specimens closely enough for identification.

12. **Phalacrocorax carbo** (Linn).

[36] *Phalacrocorax novaehollandiae.* Forbes, p. 533.

The Black Shag is quite numerous at the Chatham Islands, and breeds on the shores of many of the small lakes. Where there are suitable trees it nests in them, but in other places it builds a heap of sticks and grass on flax bushes or on the ground. In a colony inhabiting the shores of the small lake Rotokawau, south of Wharekauri, eggs and young in all stages of incubation and development were found (December 12th).

The newly hatched young are naked, with a dark slaty-blue skin, the bill, the top of the head and the throat pale pinkish-yellow, and pale bluish around the eyes: the feet are pale horn. When the sparse close black down appears the bill and pouch become pale horn, and the pale horn of the feet and tarsi becomes tinged with black. Later, when the down begins to be replaced by the juvenile brown feathering, the ocular and gular skin becomes greenish yellow, in which the yellow component increases in intensity as growth proceeds, becoming finally a rich pure yellow, while the feet and tarsi become increasingly black. The adults had already lost the white breeding plumelets of the neck and flanks, but the general plumage was still in good condition.

Microcarbo brevirostris (Gould).

[37] *Phalacrocorax brevirostris.* Forbes, p. 533.

Forbes includes the White-throated Shag in his list, apparently on the authority of Buller (2nd edition, ii., p. 170).

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* The Ibis, 1913, p. 238

We did not see it, however; but Mr. R. McClurg states that there is a second small dark shag on the south coast, the identity of which, however, is uncertain.

13. **Phalacrocorax carunculatus onslowi** Forbes.

[39] *Phalacrocorax onslowi.* Forbes, p. 533.

[40] *Phalacrocorax rothschildi.* Forbes, p. 537.

CHATHAM ISLANDS WHITE-BREASTED SHAG.

This species has usually been referred to under the common name of "Pitt Island Shag," while *Stictocarbo featherstoni* has been called the "Chatham Island Shag." These trivial names should certainly be reversed, for *P. onslowi* breeds all around the shores of the main island and is relatively uncommon on Pitt Island, while *S. featherstoni* seems to be almost restricted to Pitt Island and its rocky outliers.

The breeding phases of *P. onslowi* were well advanced by the middle of December, and adults secured had lost the crest though not in heavy moult. We are able to note the following changes in colours of the skin:—

Fledgling—Iris greyish brown, eye surrounded by narrow brownish ring. Upper mandible dark horn, lower bluish white at base, horn at tip; gular pouch pale bluish white, facial skin blackish brown; feet brownish black.

Immature—Iris greyish-brown; upper mandible blackish-horn, lower bluish-white at base, horn at tip; gular pouch bluish-white; facial skin and feet slightly lighter than in fledgling.

Adult (in late breeding, but not in mating plumage)—Iris olive brown, eye surrounded by slate blue ring; bill blackish on culmen, otherwise greyish horn; gular pouch and facial skin orange red, the latter with bright orange caruncles; feet flesh pink.

The immature forms had no white dorsal spot, but this was present in the adults.

14. **Stictocarbo featherstoni** (Buller).

[38] *Phalacrocorax featherstoni.* Forbes, p. 533.

PITT ISLAND SPOTTED SHAG.

Buller (Suppl. ii., p. 36), on the authority of Captain Hood, reported this pretty species as being almost extinct; but during our stay on Mangere Island we saw it frequently. *P. onslowi,* however, as mentioned above, was but seldom seen in this vicinity.

A breeding place on the eastern rocks of Mangere Island was all but deserted, and we obtained only one immature bird; but while we rowed about off Little Mangere, waiting for a chance to land, we saw several quite young birds, standing in "pot-holes" on the cliff face, and still being fed.

The colours of the immature bird are—Iris greyish brown; bill horn, with blackish culmen; gular skin greyish yellow, facial skin brown; feet dull yellow, except on outer surface of tarsus and outer toe, which are brown.

Adult—Iris black; gular and facial skin olive green; feet bright orange-yellow except for the brown on the outer edge.

15. **Sterna striata** Gmelin.

[25] *Sterna frontalis.* Forbes, p. 530.

The White-fronted Tern was found breeding in moderate numbers on most of the rocky headlands, or on high shingle-strewn beaches. By the end of December the young were flying strongly, but were still being fed by the parent birds.

Chlidonias albistriata (Gray).

[26] *Sterna antarctica.* Forbes, p. 530.

This is another of the birds listed by Forbes, but without any information being given as to its occurrence on the Chatham Islands. It is doubtful if it should be included in the bird-list of these islands.

16. **Larus dominicanus** Lichtenstein.

[22] *Larus dominicanus.* Forbes, p. 529.

The Black-backed Gull breeds both on the coast and inland. On the shore rocks its nest is a scrambled heap of dried sea-weed, inland it is of grass and bracken. The spot chosen by the inland-breeding colony was among low half-dead sparse bracken, whose withered grey and dull green form as effective a back-ground for the grey and black nestlings as do the rocks by the shore. Eggs, nestlings just hatched, and moderately well-grown nestlings were seen on December 12th, and the latter were fledged three weeks later.

17. **Larus novaehollandiae** Stephens.

[23] *Larus scopulinus.* Forbes, p. 529.

The Red-billed Gull is a very common species around the rocky coasts; but its rough nest of twigs and seaweed, was found only on rocks well out from the shore and difficult to reach.

At Christmas time eggs, and young in various stages of down were seen, while at Mangere Island three weeks later they were well fledged.

Larus bulleri Hutton.

[22] *Larus bulleri.* Forbes, p. 530.

We think that the Black-billed Gull has been mistakenly included in Forbes' list.

18. **Catharacta lönnbergi** Mathews.

[27] *Stercorarius antarcticus.* Forbes, p. 530.

A few Skua Gulls hover about the north coast, but do not appear to breed there. Mangere Island, however, has many constantly present, breeding on "The Point," as the lower western portion of that island is named. By the middle of January only two of the season's young remained under parental care, and one of these, with the last traces of nestling down, was secured. It is more uniformly dark than the adult birds, lacking the paler tips of the feathers of the back, which give the latter a somewhat "worn" appearance. The parent birds have the same habit as the black-backed gulls of hovering and sweeping overhead when their breeding place is trespassed upon; but their call is very weak in comparison with that of their smaller relative, while the cry of the young skua is scarcely louder than the whistling of the wind in the trees.

19. **Gallinago pusilla** Buller.

[20] *Gallinago pusilla.* Forbes, p. 529, pl. 14, figs. 1, 2, pl. 15, fig. 1.

Mr. and Mrs. T. McClurg, who are familiar with the Chatham Island Snipe on South-east Island, inform us that it is still quite common on that island. It is, however, the only place where it is now to be found.

20. **Limosa lapponica** (Linn).

[21] *Limosa novae-zealandiae.* Forbes, p. 529.

The Bar-tailed Godwit visits the great lagoon, Te Whanga, regularly every summer, and several were seen there, but none secured.

21. **Haematopus ostralegus** Linn.

Not listed by Forbes.

We saw only one Oyster-Catcher (on the shore at Mangere Island), but Mrs. H. G. Blyth has found them breeding on the boulder-strewn shore of the south-western coast.

22. **Charadrius bicinctus** Jardine and Selby.

[18] *Charadrius bicinctus.* Forbes, p. 528.

The Banded Dotterel is common on the "clears," where it breeds. We obtained a couple of immature specimens on December 18th. *Charadrius obscurus* (Gmelin) is not known from the Chatham Islands.

23. **Thinornis novæseelandiae** (Gmelin).

[19] *Thinornis novae-zealandiae.* Forbes, p. 528, pl. 14, figs. 5 and 6, pl. 15, fig. 2.

Mr. T. McClurg described to us a bird which he says is still fairly common on South-east Island, and which we believe to be the Sand Plover.

24. **Cabalus modestus** (Hutton).

[33] *Cabalus modestus.* Forbes, p. 532, pl. 14, fig. 4.

It is to be regretted that nothing can be said to question Rothschild's justification for including the Mangere Rail in his "Extinct Birds" (p. 127). The writers had a seventeen-days' sojourn (part enforced) on Mangere Island, and failed to find any trace of the bird on this now completely grassed island; while the adjacent Little Mangere, whose narrow summit is still bush-clad, does not seem to possess sufficient likely swamp area to maintain it. Unfortunately the conditions which kept us on Mangere Island for a longer period than we had anticipated were sufficient to prevent our gaining the cliff slopes of Little Mangere, the last possible refuge of *Cabalus modestus*, and of the Chatham Islands Tomtit, Bell-bird, Fern-bird, and Yellow-fronted Parrakeet.

25. **Nesolimnas dieffenbachii** (Gray).

[32] *Cabalus dieffenbachi.* Forbes, p. 531.

It was not to be expected that any indications of the existence of Dieffenbach's Rail would be found. There are several keen observers on the islands who are alive to the remote possibility of its occurrence, and who would recognise it if secured.

26. **Gallirallus australis** (Sparrman).

[extinct (12)] *Ocydromus australis.* Forbes, p. 545.

Travers (Trans. N.Z. Inst., vol. 1, p. 125) stated that Maoris had reported the previous existence of the Weka, and Forbes identified it from a few sub-fossil bones. In 1905 *G. australis*

was reintroduced, and has rapidly spread over the whole of the main island, where it is now regarded as a nuisance, at least near chicken runs and gardens. It is of the ordinary type of *G. australis,* and it will be of interest for future observers to note if it develops the melanistic condition which is regarded as being associated with a humid climate such as the Chatham Islands experience.

27. **Porzana plumbea** (Gray).

[30] *Ortygometra tabuensis.* Forbes, p. 531.

This Rail was not secured, though one of us (G.A.), while forcing a way through the high rushes, saw one at a distance of four feet. Mr. W. Jacobs has recognised it in four specimens which his dogs have caught within the last five years.

28. **Porzana affinis.** (Gray).

[29] *Ortygometra affinis.* Forbes, p. 531.

Mr. Jacobs also described a Rail, brought in by a dog several years ago, which was probably *P. affinis.* He considers it to be a rare bird in the islands.

29. **Porphyrio melanotus chathamensis** Sharpe.

[29] *Porphyrio chathamensis.* Forbes, p. 531.
[28] *Porphyrio melanonotus.* Forbes, p. 530.

The Chatham Island Swamp Hen is common in the swamps and around the shores of the many lakes, though the many bracken fires on the adjacent "clears" not infrequently sweep through the rushes, and must destroy many nests and young. In this connection we may mention the finding of a nest with fresh eggs on Christmas Day, three weeks after such a fire had passed through the edge of the swamp.

30. **Hemiphaga chathamensis** (Rothschild).

[17] *Carpophaga chathamensis.* Forbes, p. 527.

It is curious that a statement should have been made to Travers (Trans. N.Z. Inst., vol. 1, p. 125) both by Mr. Hunt, of Pitt Island, and by the Maoris, that the pigeon "was first seen on the islands within the last eight years" [about 1860], when Buller (2nd ed., i., p. 233) had seen them there "consorting with a flock of common dove-cot Pigeons" in 1855. Buller, however, seems to have accepted the statement that the species had only recently arrived there; but the fact that it is a separate species, coupled with the finding of bones in an ancient

midden by Forbes ("Nature," vol. 46, p 252) proves that the idea was erroneous. Buller reported the pigeon as fairly plentiful in 1888, but five years later Forbes (p. 527) stated that it was becoming scarce, and by 1905 the late Mr. Hawkins had reported to Buller (Suppl. i., p. 41) that it was nearly extinct.

It is gratifying, therefore, to be able to record that this species is at the present time abundant, both among the *karaka* groves of the northern sandhills, and in the denser bush of the southern plateau. This increase is generally accepted by the residents as being due to the legal protection which now covers this and all other native birds, and which has resulted in the increase in numbers of several other species formerly in danger of extinction. The pigeon in several places lives quite close to houses, and this is evidence not only of its returning numbers, but of the regard for, and in many cases the active enforcement of, the Protection Act by the residents of the islands.

31. **Anas superciliosa** Gmelin.

[52] *Anas superciliosa.* Forbes, p. 543.

The Grey Duck is now by no means numerous on the Chatham Islands. Residents draw attention to the increase in numbers of the introduced black swan as the probable cause of the fewness of grey duck.

32. **Carsarca variegata** (Gmelin).

[53] *Rhynchaspis variegata.* Forbes, p. 543.

We saw no specimens of the Paradise Duck.

33. **Egretta alba** (Linn).

[34] *Ardea egretta.* Forbes, p. 533.

The White Heron has been but rarely seen on the islands, and we do not know of any record of its breeding there.

34. **Botaurus poeciloptilus** (Wagler).

[35] *Botaurus poeciloptilus.* Forbes, p. 533.

Mr. R. McClurg, of Te Roto, says he has not seen the Bittern for the past fourteen years.

35. **Circus approximans**. Peale.

[16] *Circus gouldi.* Forbes, p. 527.

The Harrier was frequently seen on the main island, but was less evident on Mangere Island, where the Skua Gull attacks it, as we occasionally saw.

36. **Cyanorhamphus novaezelandiae** (Sparrman).

[14] *Cyanorhamphus novae-zealandiae.* Forbes, p. 526.

The Red-fronted Parrakeet is another bird that has increased in numbers recently. At one time it was common over the whole island, but later became so rare as to be found only in the dense bush far back in the southern table-land. It has recently, however, returned to the clearings, and even to the vicinity of the homesteads. We also found it on Mangere Island, where we hoped to obtain the next species.

37. **Cyanorhamphus auriceps forbesi** Rothschild.

[15] *Cyanorhamphus forbesi.* Forbes, p. 526.

We are rather doubtful as to the continued existence of this bird. Mr. H. Clough, who owns Mangere Island, and at whose kind invitation we visited it, believes, however, that it still exists on Little Mangere. He states while he has frequently seen *C. novaezelandiae* on Mangere, he has never seen *C. forbesi* there; on Little Mangere he has seen the latter but not the former. But of those specimens of *C. novaezelandiae* we saw on Mangere Island two pairs at least (we obtained one of each pair) seemed to have flown straight across the Point from Little Mangere, and we find it difficult to believe that *C. forbesi* would not, or could not, cross the two or three chains which separate the two islets.

38. **Lamprococcyx lucidus** (Gmelin).

[13] *Chrysococcyx lucidus.* Forbes, p. 526.

We did not see the Bronze Cuckoo, and heard it but once. Locally it is called the "summer-bird," and is well known on the main island, where it parasitises the nests of *Gerygone albofrontata.*

39. **Urodynamis taitensis** (Sparrman).

[12] *Eudynamis taitensis.* Forbes, p. 525.

Mr. R. McClurg described the Longtailed Cuckoo, which, he said, is very infrequently seen.

40. **Myiomoira macrocephala** (Gmelin).

[2] *Myiomoira macrocephala.* Forbes, p. 524.

The Tomtit is not common on the northern coast, but was frequently seen on the southern plateau and on Mangere Island. Its absence in the north seems to be due to the lack of undergrowth, which is there regularly destroyed by grazing stock.

41. **Miro traversi** Buller.

[1] *Miro traversi.* Forbes, p. 524.

The Black Robin is now restricted to Little Mangere, where Mr. Clough states it is still to be found. None has been seen on the mainland for many years. The numbers of its close relative, *M. dannefaerdi* on the Snares (Archey, Rec. Cant. Mus., vol. 2, p. 117, 1923) lead us to hope that it may long be preserved on the natural sanctuary of Little Mangere.

42. **Rhipidura flabellifera** (Gmelin).

[6] *Rhipidura flabellifera.* Forbes.

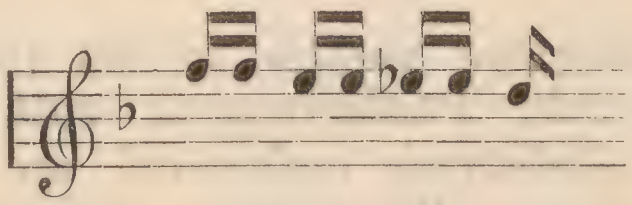
The Pied Fantail's distribution on the islands is the reverse of that of the Tomtit, for it is found most frequently in the north, and near the homesteads. A nest found at Maunganui on December 16th, contained four fledglings.

Forbes's listing of *R. fuliginosa* ([7], p. 524) without comment, was probably in error.

43. **Gerygone albofrontata** Gray.

[3] *Gerygone albofrontata.* Forbes, p. 524.

Buller (Suppl. ii., p. 119) writes of "this rare species, now on the borderland of extinction." We are pleased, therefore, to be able to record our opinion that it is by far the commonest native bush bird on the Chatham Islands, and perhaps the tamest. In the north they are only moderately abundant, but in the south they were constantly around us, particularly on the scrub country of the plateau. The residents call them "woodpeckers" suggestive of their busy tip-tipping along the twigs and branches in their search for insects. Breeding was well past in January, and the numerous immature forms we saw, distinguishable by their dirty-yellowish-white underparts, indicate that the species has a firm hold on existence. They were not, however, much given to song, and the best we heard was but a faint trill of four notes.



44. **Bowdleria rufescens** (Buller).

[4] *Sphenœacus rufescens.* Forbes, p. 524.

Our remarks as to *Miro traversi* apply equally to the Chatham Island Fern Bird.

45. **Zosterops lateralis** Latham.

[8] *Zosterops caerulescens.* Forbes, p. 524.

Like the Tui, to be mentioned, the Silver-eye is as common around the homesteads as in the bush. It was plentiful also on Mangere Island.

46. **Anthornis melanocephala** Gray.

[11] *Anthornis melanocephala.* Forbes, p. 525.
[10] *A. melanura,* p. 525.

We had hoped that if the Bell-bird still existed on Little Mangere we might have either seen a specimen on the larger islet, or have heard it in the early morning from the Point; but we had no trace of it, and its extinction seems only too certain.

47. **Prosthemadera novaeseelandiae** (Gmelin).

[9] *Prosthemadera novae-zealandiae.* Forbes, p. 525.

The Tui has always held its own, and is common on all parts of the islands, particularly, in the season, among the flax-bushes which have been planted around most of the houses. The throat plumes are distinctly larger than in the mainland forms, to the first noting of which fact we are indebted to Mr. E. J. Haynes, of the Museum staff. We saw six flying together over Mangere Island, but they do not appear to breed there.

48. **Anthus novaeseelandiae**. (Gmelin).

[5] *Anthus novae-zealandiae.* Forbes, p. 524.

The Pipit also is extremely abundant on the spacious "clears." A nest found, in the middle of January, contained a couple of fledglings, one considerably more developed than the other: both were heavily infested with a minute mallophagid.

CONCLUSION.

Forbes gave fifty-five species in his list, of which four (*Pelecanoides berardi, Phalacrocorax rothschildi, Porphyrio melanonotus,* and *Anthornis melanura*) are here regarded as synonyms, and five (*Microcarbo brevirostris, Chlidonias albistriata, Larus bulleri, Eudyptes pachyrhynchus,* and *Rhipidura fuliginosa*) as mistakenly included. We have added *Haematopus ostralegus* and *Gallirallus australis* (reintroduced). Of the forty-eight species in the present list thirty-five were secured, seen, or reported on safe authority, and may be

regarded as being regular breeding species. Four (*Ardetta alba, Botaurus poeciloptilus, Urodynamis taitensis*, and *Casarca variegata*) are rare or chance visitors; three (*Gallinago pusilla, Thinornis novaeseelandiae,* and *Porzana affinis*) are reported doubtfully, and two others (*Miro traversi* and *Bowdleria rufescens*) reported still more doubtfully. We doubt the existence of *Anthornis melanocephala* and *Cyanorhamphus forbesi*, while *Cabalus modestus* and *Nesolimnas dieffenbachii* have long been regarded as extinct.

THE GENUS CRYPTOPS (CHILOPODA) IN NEW ZEALAND

By Gilbert Archey, M.A., Assistant Curator.*

INTRODUCTION.

Since 1845, when Newport described *Cryptops australis* from a specimen taken in the South Island of New Zealand, thirteen species of the genus have been described from the mainland and outlying islands. These are—*megalopora,* Haase, 1887; *spinipes,* Pocock, 1903 (including *setosus,* Pocock, of the same paper); *polyodontus,* Attems, 1903; *zelandicus* and *lamprethus,* Chamberlin, 1920; *galidus, ignivia, algidus, dilagus, akaroa,* and *pelorus,* Archey, 1921; and *tokatea* and *arapuni,* Archey, 1922.

A detailed examination of a large number of specimens has revealed a considerable amount of variation associated with the growth of these centipedes, and has also shown the development of distinct secondary sexual characters in mature forms of relatively large size. As some of these growth and sexual variations have been used to characterise species, the number of species now to be recognised is reduced, and those herein regarded as valid are given below with their synonyms.

Cryptops australis Newport, 1845.
C. galidus Archey, 1921.

Cryptops megalopora Haase, 1887.

Cryptops spinipes Pocock, 1891.
C. setosus Pocock, 1891.
C. zelandicus Chamberlin, 1920.

Cryptops polyodontus Attems, 1903.

Cryptops lamprethus Chamberlin, 1920.
C. pelorus Archey, 1921.
C. tokatea Archey, 1922.

Cryptops dilagus Archey, 1921.
C. ignivia, C. algidus, C. akaroa Archey, 1921.

Cryptops arapuni Archey, 1922.

I have given the foregoing summary of results first in this paper, in order that the observations as to the variability of characters, or as to their nature as secondary sexual characters may be referred to the species herein recognised.

Among the characters which have been used to distinguish species are the following:—

(*a*) Dorsal sulci.
(*b*) Prosternal margins.

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* Now Curator, Auckland Museum.

(*c*) Coxopleural pores.
(*d*) Setae and teeth on anal legs.
(*e*) Setae on penult legs.
(*f*) Form of anal sternite.
(*g*) Keel on first tarsus of anal legs.

The writer has made a detailed examination of these characters as represented in a large series of New Zealand centipedes of the genus *Crytops,* and the result of this examination is given hereunder in support of the arrangement of the key to species set out below.

(*a*) *Dorsal sulci—head and tergites.*

Only one specimen has been seen which is devoid of submedian longitudinal sulci, and the species *C. arapuni* rests upon this one specimen. In this case, however, there can be discerned a submedian pair of short faint cracks at the caudal margin of segments 5 to 18. This, of course, suggests a relationship to *C. lamprethus,* which possesses distinct sulci on these tergites, and, indeed, *C. arapuni* resembles *C. lamprethus* in other respects. The large size of the specimen (42 mm.), and the fact that the sulci are without exception well developed on all specimens of *C. lamprethus,* and on the closely related *C. polyodontus,* render it desirable for the present to maintain *C. arapuni* as a distinct species.

The presence of submedian sulci on the head is a very distinctly marked character, exhibiting practically no variation; that is to say, where these sulci are present they are almost invariably complete and unbroken. They are associated with the presence of a "Collar-sulcus" on the anterior portion of the first tergite.

The other species under review, *i.e.*, those without cephalic sulci, and with the head slightly overlapped by the first tergite, have tergal sulci in varying degrees of completeness from the 4th to the 20th segments. Although a moderate amount of individual variation, or age-variation, is present, the condition of these sulci forms one of the most constant of the distinguishing characters observed, and by it *C. australis* and *C. dilagus* on the one hand can be separated from *C. lamprethus* and *C. polyodontus* on the other. The former have broken sulci on segments 4 and 5, or 3 and 4, or 3 to 5, and well marked unbroken sulci from 6 to 19, the 20th tergite possessing them either broken (usual condition) or unbroken. This may be expressed in the formula (3–5)6–19(20), the brackets being understood to indicate incomplete sulci. The formula for *C. lamprethus* and

C. polyodontus is (3–7)8–18(19). I have noted only one exception to this formula in a specimen frm Hawke's Bay, (3–7)8–20. It should be stated, however, that in large specimens of *C. lamprethus* tergite 6 and 7 may possess complete sulci, but they are faint and irregular, in marked contrast to the straight, deeply incised sulci on 8. In *C. australis* and *C. dilagus* the complete sulci on 6 and 7 are straight and strongly marked as on the succeeding tergites. On the whole the incomplete sulci extend further cephalad and caudad in the larger, *i.e.*, older specimens, but very rarely go beyond the limits as given in the above formulae.

The lateral crescentic sulci also are more strongly impressed, and are present on more segments in older forms, but their limits are less easy to discern because they fade out in the form of shallow depressions on the anterior and posterior tergites, instead of ending abruptly as do the submedian sulci.

(*b*) *Prosternum.*

Three conditions can be recognised in the form of the anterior margins of the prosternum.

(*a*) narrow, rounded, and provided with fairly stout setae in *C. spinipes*;

(*b*) of moderate width and convexivity and with only a few small submarginal hairs in *C. megalopora, dilagus, algidus, lamprethus,* and *arapuni*; and

(*c*) broad, nearly straight, and with a few submarginal hairs in *C. polyodontus.*

There is, however, considerable variation in group (*b*), in which large specimens are apt to have broader margins. The convexity of the margins as observed is, I believe, due in part to the varying degrees of contraction of the toxicognath muscles, as in any one species, convex margins are usually associated with considerable overlapping of the claws. *C. lamprethus*, however, has rather wider (not necessarily staighter) margins than the other species grouped under (*b*) for this character. The broad straight margins of the prosternum in *C. polyodontus* are, however, quite distinct; the claws, too, in this species, are slightly longer than in *C. lamprethus.*

(*c*) *Coxopleural Pores.*

The number of coxopleural pores varies in accordance with the size of individuals as is shown in the following table based on specimens of *C. dilagus* from Canterbury.

Length	Pores.
10 mm.	15
12	20–30
13	23
14	20
15	20–30
16	30
17	26–30
18	33–55
19	37–44
20	30–60
21	44–76
22	51–55
23	40–64
24	40–65
25	55–75
26	54–72

Other specimens of this species from different localities are up to 34 mm. in length and have as many as 85 pores. There is evidently a good deal of individual variation here, as well as a general increase in number with age. I have not been able to discover any differences due to sex, nor to locality or habitat, except that three specimens which I collected on the dry summit of Cass Hill, in Eastern Canterbury, have the pores appreciably smaller than the other specimens.

In spite of the individual variation, however, the number of the pores is relied upon to distinguish *C. australis* Newport, from *C. dilagus* Ar. In the latter it will be noted that as a rule there are more than 30 pores, and no specimen which has reached 20 mm. in length has less. The specimens which I have referred to *C. australis* range in size from 19 mm. to 35 mm. and have only from 17 to 31 pores, confined to a restricted oval area, thus leaving very wide pore-free areas caudally and dorso-caudally. Kraepelin's (1903, p. 58) description of the type of *C. australis* Newport, which is from the South Island of New Zealand, notes not more than 30 pores in a 30 mm. specimen, and I find that this constantly small number of coxal pores, combined with a certain condition, to be described below, of the setae covering the anal and penult legs, marks a well defined species. Although there is a good deal of overlapping in the coxopleural pores of *C. dilagus* and *C. lamprethus,* in that large specimens of the former have from 70 to 85 pores as have many specimens of the latter, it is found, however, that in specimens of equal size the greater number of pores is present in *C. lamprethus.* Individuals of *C. dilagus* from Lake Manapouri, 27 to 33 mm. in length,

possess from 73 to 85 pores, while those of *C. lamprethus* of the same sizes have 100 to 150, occupying practically the whole of the coxopleural surface and leaving no pore-free margin as is usually the case in *C. dilagus*. A study of the localities in relation to the number of pores suggests that the larger number of pores is associated with a damp climate, and the smaller number with dry conditions, and also that the pores are smaller in individuals from dry localities. Similar tables showing an increase in the number of pores as the length increases could be given for *C. lamprethus*, *C. polyodontus*, *C. megalopora*, and *C. spinipes*.

Anal Legs.

The number of teeth on the ventral surface of the femur, tibia, and first tarsus of the anal legs has been used to define species. Attems (1903, p. 106) characterised *C. polyodontus* by its possession of numerous teeth in several rows on the tibia, and the writer (1921, p. 183) separated species by the greater or lesser number of anal teeth, and by the presence or absence of a ventral keel on the first tarsus. The latter character as distinguishing *C. ignivia* from *C. algidus* (= *dilagus*) is of no value, being caused by the degree of flexing of the joints. In *C. lamprethus* and *C. polyodontus* a strongly developed keel is now found to be a secondary sexual character of mature males (Pl. xxxvi., fig. 2, Pl. xxxv., fig. 4).

The smaller number of teeth (1+9+4) of my *C. ignivia* and *C. algidus* and the larger number (1+12+7) of *dilagus* and *akaroa* come within the degree of variability now found in *C. dilagus* to be associated with varying sizes, as the following table shows:—

C. dilagus.

Length.	Average.
12 mm.	1+6+4
13	1+8+4
15	1+8+5
16	1+7+4
17	1+8+5
18	1+7+5 to 2+10+6
19	1+6+6 to 1+10+5
20	1+10+6 to 1+11+7
21	1+9+6
22	1+9+2 to 2+15+8
23	1+9+6 to 2+8+5
24	1+9+5 to 1+12+10
25	1+11+7 to 1+13+6
27	1+11+7 to 1+13+7

A similar increase is found in all species examined. More interesting is the result of an examination of the tibial teeth of a large series of *C. polyodontus* and *C. lamprethus.* In both these species there was observed in many specimens, a considerable number of small teeth arranged in 2 to 4 rows, and in every case the individuals were of a large size, and were found by dissection to be males. The females, on the other hand, possess only one row of teeth, of a larger size than found in the males. (Pl. xxxv., fig. 5).

I have not, however, united *C. lamprethus* with *C. polyodontus,* because I find other small differences between them to be constantly present. When Attems (1903, p. 106) described *C. polyodontus* he had a specimen from the Chatham Islands and one from Stephen Island in Cook Strait, but his statement "Prosternum with straight truncated anterior end" indicates that his description was based on the Chatham Island form.

Occasionally large males of *C. dilagus* possess a few extra tibial teeth in a second row, but this doubling is by no means so extensive as in *C. polyodontus* and *C. lamprethus.*

Setae on Anal Leg.

While the setae generally on the anal legs show slight differences in size in the various species, the general arrangement is the same for all. The prefemur bears mesally several stout spinescent setae, ectally they are less stout; the femur mesally is provided with setae as stout as those found ectally on the prefemur; ectally the femur has still finer setae. The tibia and tarsi have the spinescent setae replaced by fine hairs of moderate length.

Penultimate and other posterior legs.

As in the anal leg a definite arrangement of the setae occurs on the penult leg. Mesally the prefemur, femur and tibia are provided with relatively few moderately stout, tapering setae; on the upper part of the ectal side these joints have similar but less stout setae which are replaced ectoventrally by more numerous fine setae; these may frequently form a short downy pubescence. Variation in these ectoventral setae has been noted by Chamberlin (1920, p. 4), and the writer (1921, pp. 186-8), and I am now able to state that these differences are sexual. In the females particularly of *C. dilagus, C. polyodontus,* and *C. lamprethus,* these ectoventral setae are fairly long and only moderately numerous (Pl. , fig. 2), moreover, they do not occur on the legs in front of the penult. In the mature males, however, the ectoventral setae are so short and numerous as to

form a very definite pubescence (Pl. xxxv., fig. 3), and a similar condition is found in varying degrees of development, according to the size of the specimens, on the legs anterior to the penult, (Pl. xxxvi., fig. 3). Usually this condition prevails only so far forward as the 10th leg, less frequently to the 6th, but occasionally even to the fourth.

These sexual differences are also found in *C. megalopora*, in which case, however, the ectoventral setae of the males are scarcely short and numerous enough to be called a pubescence. They are, however, much shorter and more numerous than in the females, and form a definite patch or area.

Of the characters mentioned above by which mature males can be distinguished from females, the presence of an ectoventral pubescence on penult and preceding legs is the most general, being found in *C. australis, C. dilagus, C. lamprethus, C. polyodontus,* and *C. megalopora;* the "doubling" of the teeth of the anal tibia is infrequent in *C. dilagus,* frequent in *C. lamprethus* and most extensive in *C. polyodontus,* while the presence of a distinct tarsal keel is found as a secondary sex character only in the males of *C. lamprethus* and *C. polyodontus.*

The constancy of these secondary sex characters is shown by the fact that out of 129 specimens dissected only one specimen (a mature male) did not show the true male condition. Apart from those dissected, the presence of the typical male conditions on both anal and penult legs, was observed on many other specimens, as was the characteristic female condition on both anal and penult legs found in others. For purposes of record I may state that I have labelled all those whose sex I have assumed from the secondary sex characters with the sex sign in brackets (♂) or (♀), and suggest the use of brackets in this manner as a general rule for denoting that the sex is inferred rather than definitely known.

Of other characters I have observed, I find the following very variable, and therefore of little or no value for systematic purpose; moreover, I have been unable to establish any sex relation with them: form of anal tergite or anal sternite, as expressed by the length and width of the triangular caudal production of the former, and the degree of emargination or convexity of the caudal margin of the latter. The acuteness or otherwise of the angles of these sclerites is also very variable. The proportions (length ÷ breadth) of the joints of the anal and penult legs have also been worked out, but individual variations are considerable, and, like the form of the prosternal margins and the tibial keel, mentioned above, may be an expression of the degree of flexing of the legs. The cruciform sternal sulci,

on the other hand, are present generally from the 2nd to the 19th segment in all the species dealt with, such slight variation as occurs being individual.

Key to New Zealand Species of Cryptops.

A.—Tergites with only faintest indications of longitudinal sulci. *C. arapuni* Archey

B.—Tergites with distinct longitudinal sulci.

I. First tergite with a transverse collar-sulcus anteriorly, and usually with its anterior margin overlapped by the head.

1. Head with submedian sulci. *C. spinipes* Pocock

2. Head without submedian sulci or with only anterior and posterior rudiments of same. *C. megalopora* Haase

II. First tergite without sharply defined collar-sulcus, always with its anterior margin overlapping the hinder margin of the head.

1. Larger; coxal pores more numerous (to over 100), prosternal margins broad and nearly straight, tergal sulci complete 8-18: formula (3-7)8-18(19).

a. Prosternal margins broader and straighter *C. polyodontus* Attems

b. Prosternal margins less broad and slightly convex. *C. lamprethus* Chamberlin

2. Smaller, coxal pores usually less than 80, prosternal margins only moderately broad, and each convex, tergal sulci complete 6-19: formula (3-5)6-19(20).

a. Coxal pores 30-80, reaching near to caudal margin. Setae of anal legs moderately numerous and fairly large. *C. dilagus* Archey

b. Coxal pores reduced to 30 on restricted oval area, even in large forms. Anal legs with very numerous small spinescent setae. *C. australis* Newport

Cryptops arapuni Archey, 1922.

"Records Cant. Mus.," vol. 2, part 2, p. 75, 1922.

Colour—Head, 1st tergite and 17th to 21st tergite ferruginous, remainder dull brown, a dark median band along the back.

Antennae, distinctly tapering, with 17 articles. *Head,* overlapped by first tergite, faintly punctured, with fine hairs.

First tergite with a Y-shaped depression. *Submedian longitudinal sulci* at most represented by a pair of faint, very short cracks at caudal margin; lateral crescentic sulci present from 3rd to 18th segments. *Prosternum* with slightly convex anterior margins, a few fine setae submarginally. *Sternites* with cruciform sulci to the 19th segment, last sternite as wide as long, with straight sides converging caudad, caudal margin convex. *Spiracles* very narrow oval, almost slit-like. *Coxopleurae* not produced caudally, pores numerous, small, reaching nearly to caudal margin, except mesally, where there is a pore-free area, set with setae. *Legs* with moderately fine setae. *Ectoventral setae of penult legs* of moderate size and number, such setae not being present on anterior legs. Anal legs missing.

Length—42 mm. Sex female.

Locality—Arapuni, Auckland District. (A. Lush).

The presence of the short submedian "cracks" on the tergites indicates that this species is not related to *C. modiglianii* Silv., and *C. monilis* Gerv., as suggested by the original description, but is an aberrant type of *C. lamprethus,* Chambr., and intermediates between it and *C. lamprethus* may ultimately be found. Only one specimen is known.

Cryptops spinipes Pocock, 1891.

(Pl. xxxiv., figs. 1–3.)

Cryptops spinipes Pocock, *Ann. Mag. Nat. Hist.,* ser. 6, vol. 8, p. 156, 1891. *C. setosus,* Pocock, *ibid.,* p. 157. *C. spinipes,* Kraepelin, *Mit. Mus. Hamburg,* vol. 20, p. 49, 1903; *Arkiv. Zool.,* vol. 10, No. 2, p 2, 1916; Chamberlin, *Bull. Mus. Comp. Zool.,* vol. 64, p. 4, 1920; Archey, *Trans. N.Z. Inst.,* vol. 53, p. 184, 1921; *C. zelandicus,* Chamberlin, *Bull. Mus. Comp. Zool.,* vol. 64, p. 9, 1920.
Adult:

Colour—fulvous.

Head, with two strongly marked sulci throughout, diverging anteriorly; in a very large specimen a short sulcus extends obliquely outward and backward from anterior third of each submedian sulcus. Head overlapping or overlapped by first tergite, the latter with distinct collar sulcus. Submedian tergal sulci (1)2–20, or (1–2)3–20; on the first tergite these sulci converge caudad, on the others they diverge posteriorly; in addition there are slender, but distinct, oblique sulci, crossing the anterior corners of the 1st to the 8th, 9th, or 10th tergites.

(Pl. xxiv., fig. 1). Lateral crescentic sulci from 3rd to 20th tergites. Anal tergite usually with longer triangular caudal production than in other New Zealand species, the apex sub-acute.

Prosternum of prehensors with convex margins of moderate width, each with 3 to 8 moderately stout tapering marginal setae. Cruciform sulci of sternites from 2nd to 18th or 20th, the transverse arm strongly recurved, the longitudinal arm extending from anterior margin to a short distance behind the transverse arm; in addition the 2nd to 9th sternites possess a slender, but distinct, diagonally-cross sulcus in anterior third, and 1st to 3rd with a faint transverse sulcus near anterior margin. All sternites punctured and setose. Legs, including penult, possessing on prefemur, femur and tibia, moderate sized, tapering setae ectally, and stout blunt spinescent setae ventrally and mesally; tarsi with setae. Anal leg with 1+10+4 stout blunt teeth; prefemur and femur with very stout blunt setae mesally and ectoventrally, tibia on mesal surface with one such seta, in addition to the fine setae which otherwise cover the articles. Distal end of tibia with a stout blunt spine dorso-ectad, and a smaller one dorso-mesad. Coxopleural pores up to 50, leaving moderate to wide caudal pore-free margin, which is armed with about 8 stout setae; the coxopleural surface generally setose.

Caudal margin of anal sternite usually slightly emarginate, but occasionally slightly convex.

Length, to 35 mm.

Distribution—Wellington, Kaikoura, Cheviot, Westland, and West Otago.

The variation of this species is associated with the size of the individuals, and is expressed by increase in prosternal setae, coxal pores, and dentition of the anal leg, also in the development of the slender accessory oblique sulci on the head and anterior tergites and of the diagonal sulci of the anterior sternites, these being represented by traces only in small specimens. These do not seem to be secondary sexual characters, but I have had too few specimens for examination to enable any definite statement to be made in this connection. By the kindness of Dr. R. V. Chamberlin, I have been permitted to have for examination the type of his *C. zelandicus,* which is a young form of this species. Its head has very faint submedian sulci, and overlaps the anterior margin of the first tergite, thereby concealing a faint collar sulcus on that tergite, which also has a pair of extremely delicate submedian sulci.

Cryptops megalopora Haase, 1887.

Cryptops megalopora Haase, *Abb. Mus. Dresden*, vol. 5, p. 80, 1887; Kraepelin, *Mit. Mus. Hamburg*, vol. 20, p. 51, 1903; Chamberlin, *Bull. Mus. Comp. Zool.*, vol. 64, p. 4, 1920; Archey, *Trans. N.Z. Inst.*, vol. 53, p. 185, 1921.

Adult—General colour—Orange, head deeper orange.

Antennae, with 17 articles, the first four with long setae, from the 5th onward, with a dense covering of short fine setae. Head usually without submedian sulci, but one large specimen with two short sulci behind antennae, and two extending forward from caudal margin for one-fifth the length of the head. First tergite with distinct collar-sulcus; submedian tergal sulci indicated on anterior and posterior margins of second, complete from 3rd to posterior margin of 20th. Slender oblique sulci across anterior corners of second to eighth tergites. Lateral crescentic sulci distinct from 3rd to 19th tergites, faint on 20th. Anal tergite without sulci, lateral margins straight, converging slightly caudad, caudal triangular portion moderately produced, with apex blunted. All tergites sparsely with long fine setae.

Prosternum of prehensors with convex, well chitinised anterior margins, no marginal setae, otherwise with a few scattered short fine setae.

Sternites: with cruciform sulci well marked from 2nd to 19th segments, the transverse arm more strongly marked, and recurved. In the anterior segments the transverse arm is slightly in front of the middle of the sternite, in the posterior sternites it is nearer the caudal margin. Anal sternite with convex, converging lateral margins, caudal margin slightly emarginate, angles broadly rounded. All sternites sparsely with fine setae, those on the anal sternite being longer than on the others.

Coxopleurae with caudal margin rounded, not produced; pores large and small, up to 50 in number according to size of the individual, arranged on an oval area, leaving only a narrow, setose, pore-free margin.

Penult leg of female provided mesally on prefemur, femur and tibia with a few moderately stout spinescent setae, ectoventrally with longer, fine setae, preceding legs without special ectoventral setae. In the male the ectoventral setae form a definite triangular patch on the distal half of the prefemur, but extend along the whole ectoventral surface of femur and tibia; they are, however, relatively larger and less numerous than the fine, dense ectoventral setae of *C. dilagus* and *C. lamprethus*, and are not usually to be found on legs in front of the 20th.

Anal leg dentition averaging 1+5+3, varying as to the length of the individual. Mesal surface of prefemur, and femur, and tibia with fairly numerous short stout spinescent setae, ectally with longer, finer, setae, tarsal joints with long fine hairs.

Length up to 27 mm., mature individuals usually about 20mm.

Locality, Auckland Islands, Haase 1887, Archey 1923.

This species stands close to *C. spinipes,* Pocock, resembling it in the possession of a collar-sulcus on the first tergite, and of oblique anterior sulci on the first few segments. It differs from *C. spinipes* by its smaller size, and the almost complete loss of the cephalic sulci, these being present as rudiments only on one specimen out of fifty examined. Small specimens are characterised by a reduction in the number of anal teeth and coxal pores, and also by a less noticeable development of the ectoventral setae of males.

The forest floor of the Auckland Islands is an extremely wet peat, and these centipedes were found only on slight eminences, which stood a foot or so above the general level, and which were consequently a little drier. A quite moderate dampness seems to be the most suitable habitat condition for all the species in New Zealand.

Cryptops polyodontus Attems, 1903.

Cryptops polyodontus Attems, *Zool. Jahrb. Syst.*, vol. 18, p 106, 1903; Kraepelin, *Mit. Mus. Hamburg,* vol. 20, p. 53, 1903; Chamberlin, *Bull. Mus. Comp. Zool.,* vol. 64, p. 8, 1920; Archey, *Trans. N.Z. Inst.,* vol. 53, p. 185, 1921.

Colour (alive), dark olivine brown, head and posterior tergites feruginous. The greenish tinge ultimately dissolves in spirit, leaving a yellowish brown.

Head, without sulci, its hinder margin overlapped by the first tergite. Tergites finely hairy, faintly punctured. Submedian tergal sulci (4–7)8–18(19), lateral crescentic sulci 3–19. Form of anal tergite variable, usually with straight sides, the caudal production moderate and the lateral angles and apex well rounded.

Prosternum (Pl. xxxv., fig. 1) very broad, the anterior margins straight or nearly so, separated from each other by a slight median nick. The claws long and curved; the whole prehensor sparsely with fine hairs.

Sternal sulci 2–18(19), anal sternite usually with slightly convex, converging sides, posterior angles moderately to well rounded, caudal margin slightly convex, straight, or slightly

emarginate. Coxopleura not produced, with nearly straight caudal margin, pores 70 to 120, covering most of coxopleure, and leaving only a narrow setose, pore-free margin.

Penult legs of female with ectoventral setae of moderate size and number, these setae not being present as such on anterior legs, penult legs of male densely with short fine ectoventral setae, which are present also on several legs preceding penult legs.

Anal legs moderately with short spinescent setae (smaller and less numerous than in the following species). Dentition: female up to 1+11+5 or 1+12+4, the teeth larger than in the male and set in a single row. Dentition of male up to 3+30+5, smaller teeth than in the female, those on tibia in several rows, those on first tarsus on a very prominent ventral keel. (Pl. xxxv., fig. 4.)

Length up to 30 mm., usually about 25 mm.

Locality—Chatham Islands, occurring on all parts where the peaty soil is of moderate dampness. Kraepelin's description (1903) gives the localities Chatham and Stephen Islands, but it would appear that the Stephen Island specimen is a mature male of the next species. I have examined such specimens from Stephen Island.

The differences between *C. polyodontus* and *C. lamprethus* are slight but constant, and are given at the foot of the next description. Smaller specimens have fewer anal teeth, and the ectoventral setae and other secondary sexual characters less well developed. The tergal sulci are less developed on segments 4 to 7 and 19, but they are usually complete though fine from 8 to 18. The prosternal margins, however, are broad, as in larger specimens.

Cryptops lamprethus Chamberlin, 1920.

(Pl. xxxvi., figs. 1–3.)

Cryptops lamprethus Chamberlin, *Bull. Mus. Comp. Zool.*, vol. 64, p. 4, 1920; *C. pelorus*, Archey, *Trans. N.Z. Inst.*, vol. 53, p. 190, 1921; *C. tokatea*, Archey, *Rec. Cant. Mus.*, vol. 2, pt. 2, p. 13, fig. 3, 1922.

Colour—Olivine brown, head and posterior tergites feruginous.

Head—Without sulci, its hinder end overlapped by 1st tergite.

Tergal submedian sulci usually (3–7)8–18(19), lateral crescentic sulci usually 3–19. Anal tergite commonly with straight sides, caudal production moderate, apex and lateral angles somewhat abruptly rounded.

Prosternum of prehensors with anterior margins of moderate width, each slightly convex and chitinised, sometimes inclined mesally; a few scattered fine hairs. Claw long and curved. Cruciform sternal sulci (1)2–18, well marked.

Coxopleurae not produced, with nearly straight caudal margin, pores large and small usually from 70 to 150 in number, reaching nearly to hinder end; pore-free caudal margin therefore narrow, provided with up to 12 stout setae.

Penult legs in mature male with dense ectoventral pubescence, which is also found to a less extent on several preceding legs.

Penult legs: female with ectoventral setae moderately long and numerous, these setae not present as such on anterior legs. Anal legs, female, dentition up to 1+11+4, moderately large teeth set in a single row, no tarsal keel; male dentition up to 2+20+8, those on tibia in two or three rows, those on first tarsus on very prominent keel. (Pl. xxxvi., fig. 2.)

Length, up to 33 mm.

Localities—North Island: Coromandel; Taumarunui; Ohakune; Mt. Ruapehu; Frankliegh Peak, Taranaki; Hawke's Bay; Waikanae; Plimmerton).

Distribution—North Island generally, and Marlborough Sounds, including Stephen Island in the South Island.

This species differs from the preceding by its slightly narrower and individually convex prosternal margins, by the more numerous and longer spinescent setae on the anal legs, and by there being a few more teeth of a larger size on the tarsal keel than in *C. polyodontus;* mature males also have fewer tibial teeth than males of *C. polyodontus* of the same size.

Chamberlin (1920, p. 4) noted the variation of the ectoventral pubescence of the penult legs, and it would now appear that his type is a male and the paratype a female or immature male.

Cryptops dilagus Archey, 1921.

(Pl. xxxvii., figs. 1–4.)

Crytops dilagus, Archey, *Trans. N.Z. Inst.,* vol. 53, p. 187, fig 6, 1921; *C. akaroa,* Archey, *ibid.,* p. 188, figs. 7 to 9; *C. ignivia,* Archey, *ibid.,* p 188, fig. 10; *C. algidus,* Archey, *ibid.,* p. 189, figs. 11 and 12.

Colour—Olivine brown when alive, yellowish brown to pale straw colour in spirit; head and posterior tergites darker.

Head, without sulci, overlapped by 1st tergite. Tergites with submedian longitudinal sulci (3–5)6–19(20); lateral crescentic sulci 3–19. Anal tergite with triangular caudal production, but variable in form. Prosternum of prehensors with chitinised convex margins of moderate width, a few hairs submarginally and scattered over prosternum.

Cruciform sulci of sternites 2 to 19. Anal sternite variable in form, angles usually moderately rounded, caudal margin slightly convex, straight or slightly emarginate.

Coxopleura usually with 50 to 60 pores, (up to 80 in large forms), leaving pore-free caudal margin of moderate width, the hinder edge with 6 to 10 fairly large setae.

Penult legs of female with slender spinescent setae except ectoventrally, where they are replaced by more numerous finer setae, but these ectoventral setae are not found on anterior legs. Penult legs of male with ectoventral setae forming a dense pubescence on pre-femur, femur and tibia; this condition being continued forward on anterior legs in accordance with the size of the individual.

Anal legs with spinescent setae on prefemur and femur long and moderately numerous, finer ectally on femur. Dental formula variable with size up to 1+12+10, usually arranged in one row, but occasionally a large male has a few smaller teeth in a second row. Strong flexion of the leg may produce the appearance of a tibial keel, but it is not a strongly developed keel as in *C. lamprethus.*

This species differs from *C. lamprethus* by its narrower prosternal margins, relatively fewer coxal pores, and the greater extension of the tergal sulci, the latter character being the most constant. Individuals from localities which possess a humid warm climate (Western Otago and Westland) rather than a dry cold one (eastern Canterbury) are generally of larger size, and have more coxal pores, and except for the tergal sulci approximate the type of *C. lamprethus.*

Distribution—C. dilagus has been collected in Canterbury from Mount Grey to the Waitaki River, in Otago to Puysegur Point, in Westland as far north as Greymouth. Its distribution in the northern portion of the South Island is therefore unknown, as also is its distribution relative to *C. lamprethus,* which occurs in the Marlborough Sounds. From Westland I have a specimen which has a tergal sulcus formula similar to that of *C. lamprethus,* and collecting in Nelson and Marlborough may reveal the existence of forms connecting *C. dilagus* and *C. lamprethus.*

Length up to 33 mm., mature forms usually about 25 mm.

Cryptops australis Newport, 1845.

Cryptops australis, Newport, *Trans. Linn. Soc.,* vol. 19, p. 408, 1845; Pocock, *Ann. Mag. Nat. Hist.,* ser. 6, vol. 11, p. 129, 1893; Kraepelin, *Mit. Mus. Hamburg,* vol 20, p. 58, 1903; *Fauna Sudw. Austr.,* vol. 2, p. 106, 1908; *Arkiv. Zool,* vol. 10, No. 2, p. 2, 1916; Chamberlin, *Bull. Mus. Comp. Zool.,* vol. 64, p. 8, 1920; Archey, *Trans. N.Z. Inst.,* vol 53, p. 186, 1921; *C. galidus,* Archey, *ibid.,* p. 186, figs. 4 and 5, 1921.

Colour, in spirit, pale straw colour, head slightly darker.

Head, posteriorly overlapped by first tergite, punctured, without sulci. Tergites with submedian longitudinal sulci, (3) 4–20, but on the 20th they are sometimes broken for a short distance, lateral crescentic sulci 3–19.

Prosternum with moderately chitinised, slightly convex margins, separated by a slight emargination, provided sparsely with small fine setae. Cruciform sternal sulci on segments 2–19, both arms equally impressed, the transverse arm recurved. Anal sternite variable in form of caudal margin. Coxopleurae with nearly straight posterior margin, with very few (about 30) pores of small size arranged on a restricted oval area bearing as many small setae; pore-free area consequently large, provided with fairly large setae in three rows, most numerous dorso-caudally.

Penult legs of female with numerous short ectoventral setae, but not forming such a fine dense pubescence as is found in the male, in which sex the ectoventral pubescence is continued forward in a reduced condition to the 16th legs.

Anal legs with much more numerous and smaller spinescent setae than in *C. dilagus,* detal formula 1+8+3 to 1+10+7 or 1+13+3, no tarsal keel.

Length, up to 35 mm.

Locality—Rockwood, and Mt. Algidus, Rakaia Gorge.

I have eleven specimens of this species, only one a female, and the localities are those in which *C. dilagus* is also found. They are all large specimens, and poorly chitinised, the latter being due to the fact that they were collected in January, when moulting takes place, in Canterbury at least. The slight extension of the tergal sulci and the more numerous finer setae on the anal legs might be the result of age, but so far as I am aware there is no record of the loss of coxal pores in specimens which have attained a large size. However this may be, I have considered it better to regard the three differences together, tergal

sulci, anal setae, and coxal pores, as maintaining *C. dilagus* separate from it. I have identified the specimens here referred to with *C. australis,* because they agree with Kraepelin's description of the coxopleure of that species and of the specially fine pubescence of the penult legs.

Conclusion.

Apart from *C. arapuni,* found in the Auckland District, near Arapuni, and *C. spinipes* from Wellington, the common North Island species of *Cryptops* is *C. lamprethus,* Chambr., which species also is found across Cook Strait in Marlborough Sounds. It is not known, however, how far it extends into the South Island. *C. polyodontus,* from the Chatham Islands, is very closely related to it, the two speces forming a pair distinct from the common South Island species *C. dilagus.*. It may be mentioned that *Lamyctes chathamensis* (Lithobiomorpha) is another Chilopod which occurs in the North Island and the Chatham Islands. *C. dilagus* is the common South Island species, but its distribution in the north of the South Island and its geographical relationship to *C. lamprethus* are not known. One specimen at least from Westland tends towards the *C. lamprethus* type, but others from that province are distinctly *C. dilagus.*

C. spinipes is either a rare species or is limited to a certain type of habitat. It is represented so far as our knowledge goes, in Wellington; on the east coast of the South Island, in the valley of the Clarence River, and as far south as Cheviot; on the west coast it is known from Hokitika and the Minaret Peaks, West Lake Wanaka, whence I have a large much sulcated specimen. It has not been represented among the collections I have examined from Puysegur Point nor from Stewart Island. A related species, however, *C. megalopora,* Haase, is abundant in the Auckland Islands, where *C. dilagus* seems to be absent. There are, therefore, still many gaps to be filled in before a complete statement of the distribution of the species can be made, and it is hoped that this restatement of the species and of the characters by which they may be recognised will enable this to be done.

Finally, I wish to thank those friends who have provided me with material, Dr. Chilton, Messrs. T. R. Harris, C. E. Clarke, Hedley Bellringer. P. Malthus, Walter Traill, J Hende, C. E. Foweraker, Stuart Lindsay, and the late Mr. T. Hall, by whose death on active service New Zealand has lost one of her most active collectors and field students of the Arthropoda.

Explanation of Plates.

Plate xxxiv.	fig. 1.	*Cryptops spinipes* Pocock	Anterior segments, dorsal aspect.
	2.	„ „	Anal leg.
	3.	„ „	Prehensors.
	4.	*C. megalopora* Haase	Anterior segments, dorsal aspect.
	5.	„	Posterior segments of male, ventral aspect.
Plate xxxv.	fig. 1.	*C. polyodontus* Attems	Prehensors.
	2.	„	Posterior segments of female, ventral surface.
	3.	„	Posterior segments of male, ventral surface.
	4.	„	Anal leg, male.
	5.	„	Tibia and 1st tarsus of anal leg, female.
Plate xxxvi.	fig. 1.	*C. lamprethus* Chamberlin	Prehensors.
	2.	„	Anal leg, male.
	3.	„	Posterior segments, male, ventral surface.
Plate xxxvii.	fig. 1.	*C. dilagus* Archey	Coxopleure.
	2.	„	Prehensors.
	3.	„	Anal leg, male.
	4.	„	Penult leg, male.
	5.	*C. australis* Newport	Coxopleure.
	6.	„	Anal leg, male.
	7.	„	Penult leg, male.

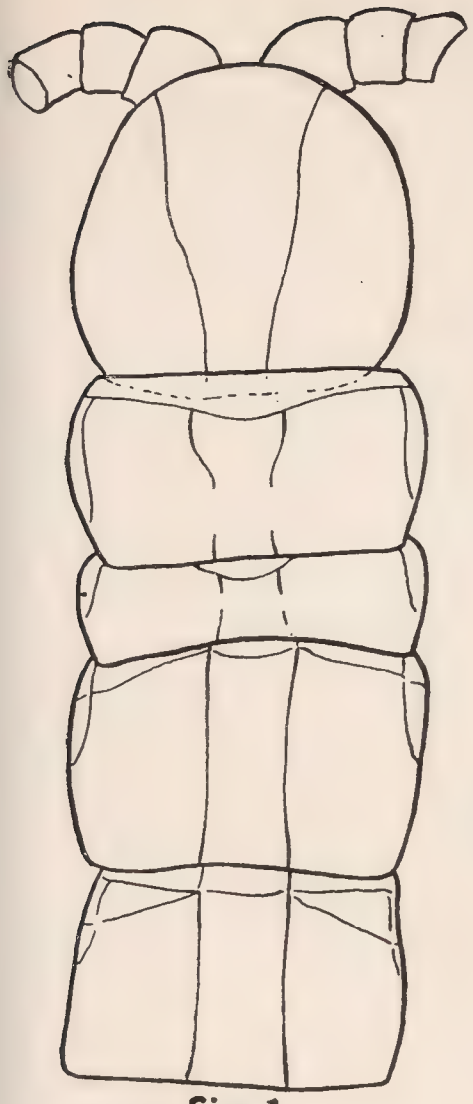

fig. 1

fig. 2

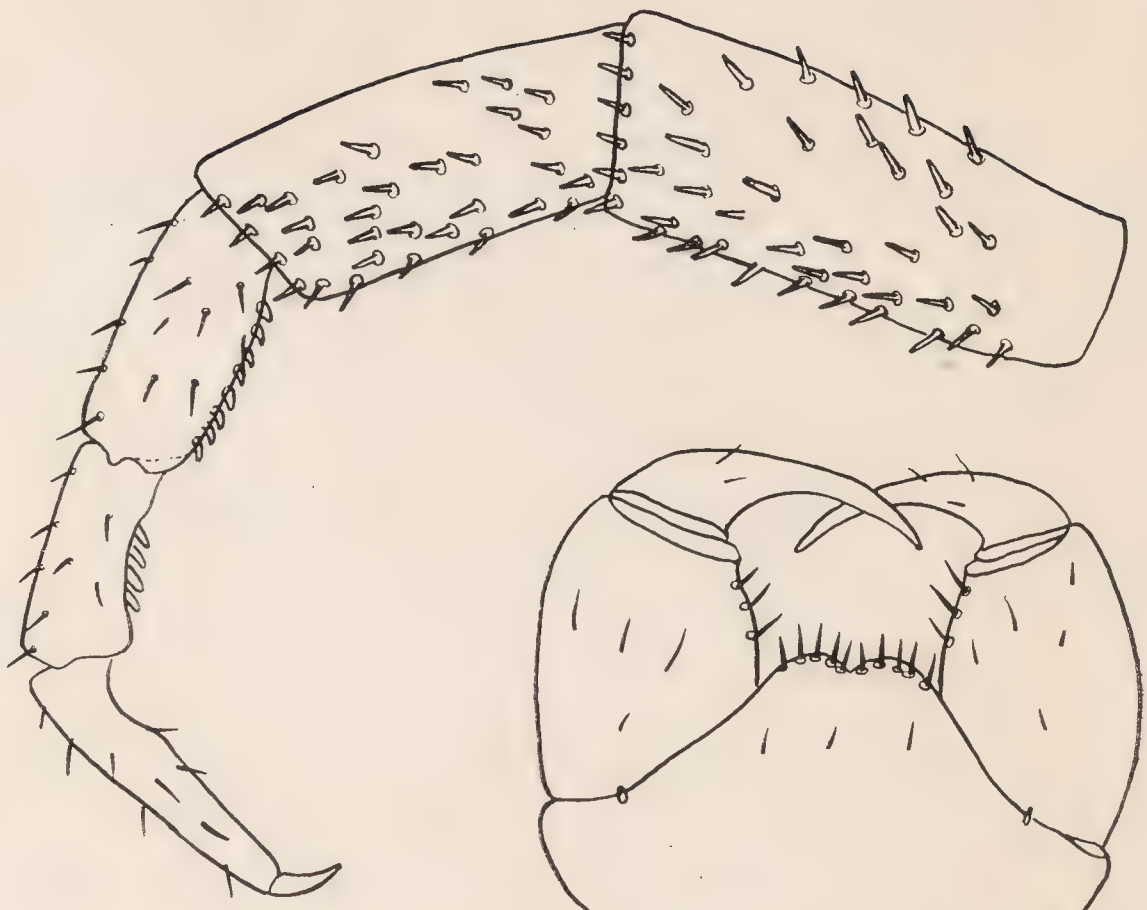

fig. 3

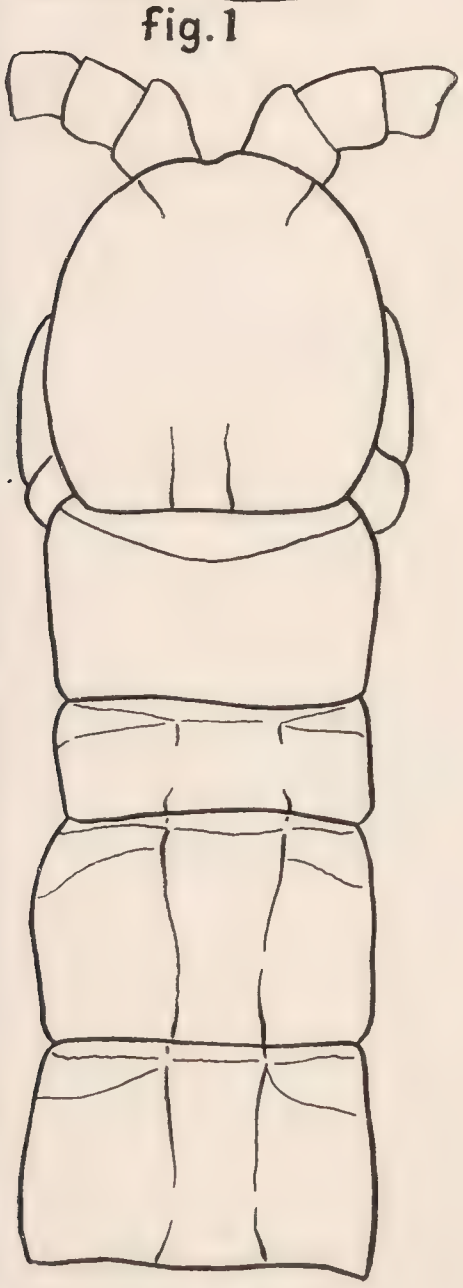

fig. 4

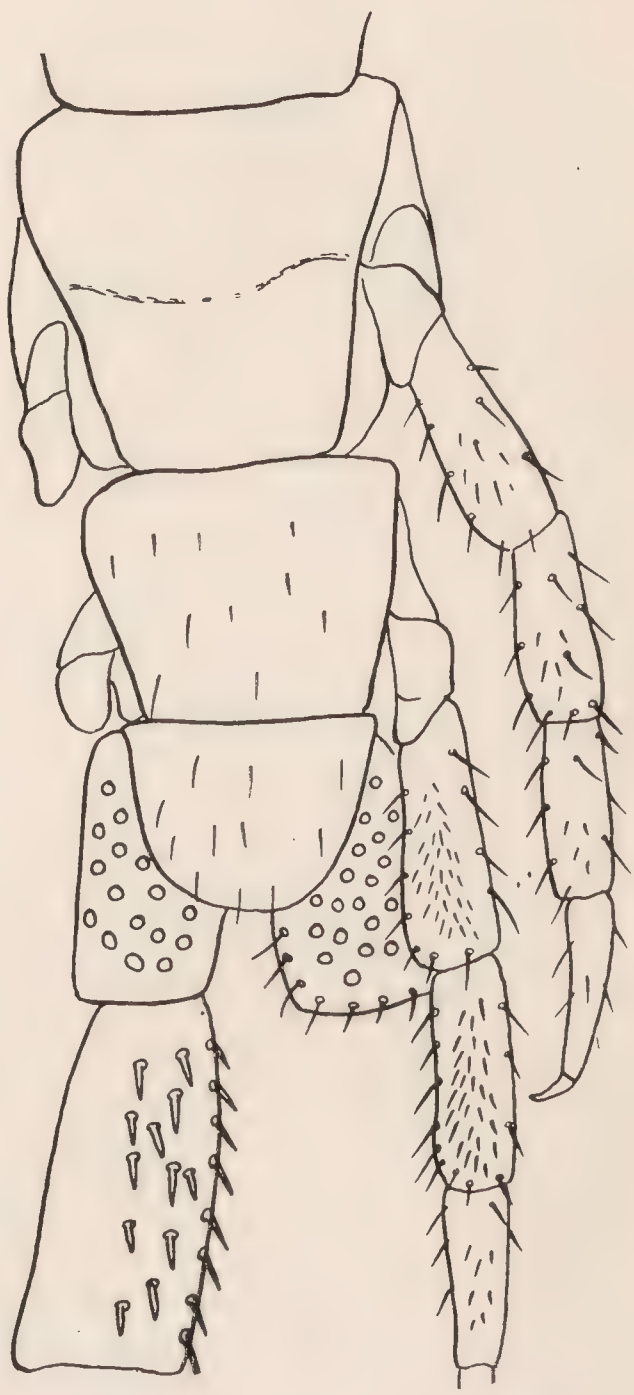

fig. 5

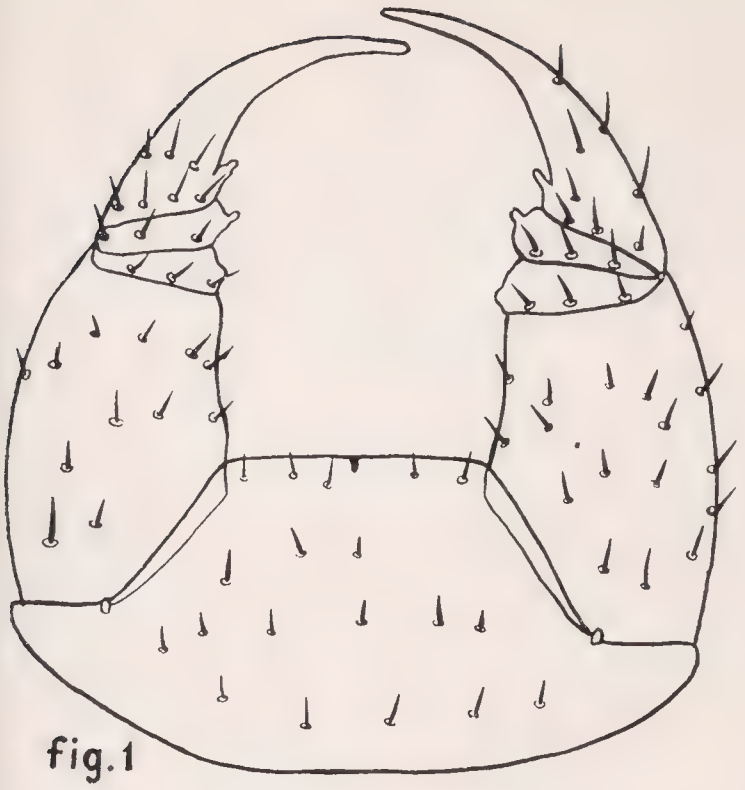

fig.1

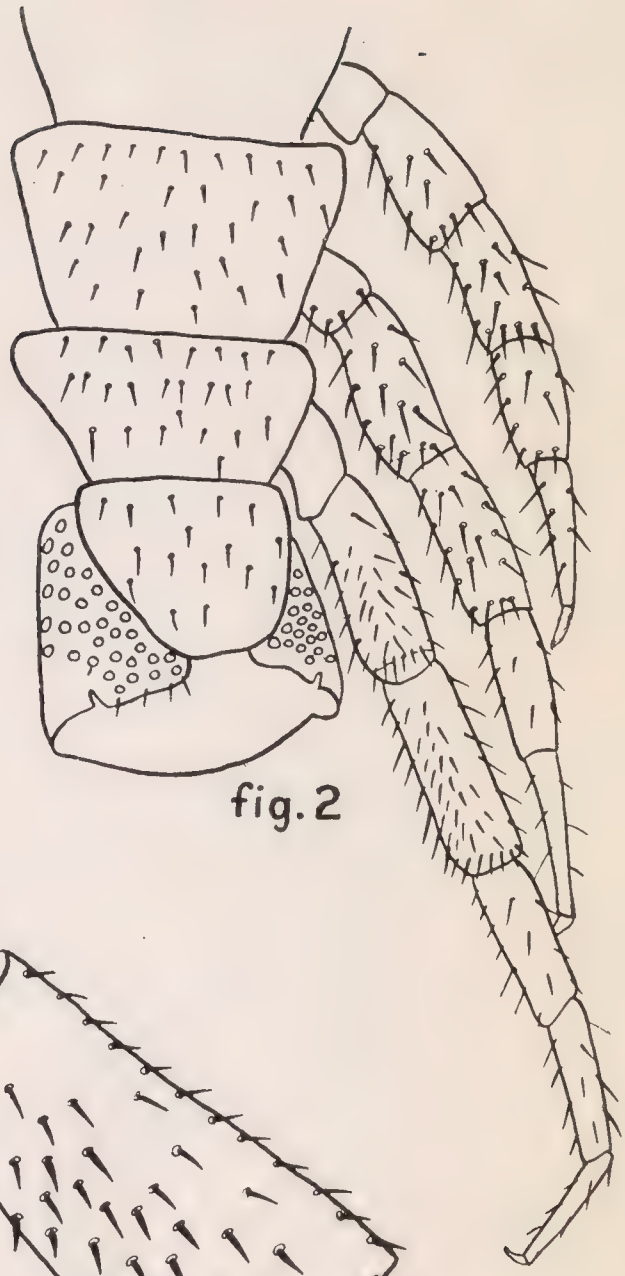

fig.2

fig.3

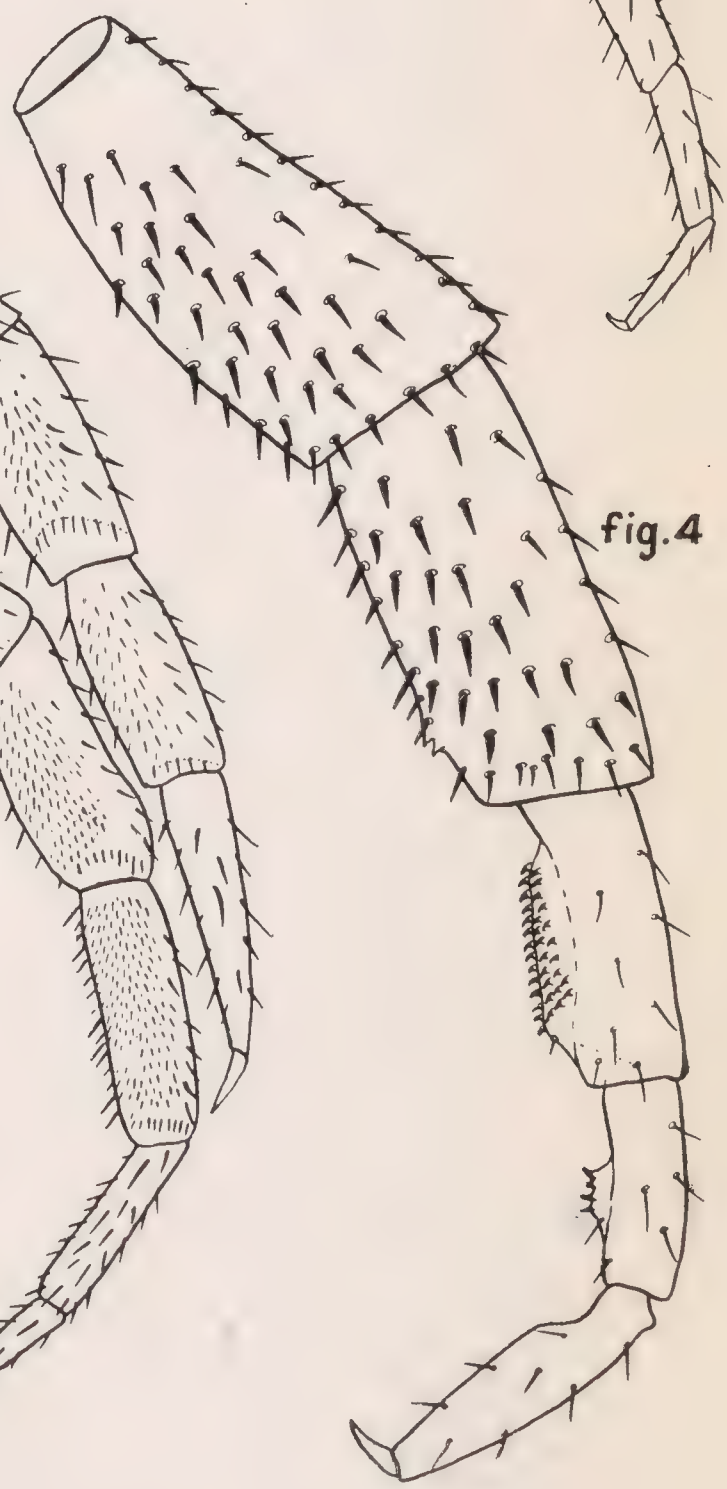

fig.4

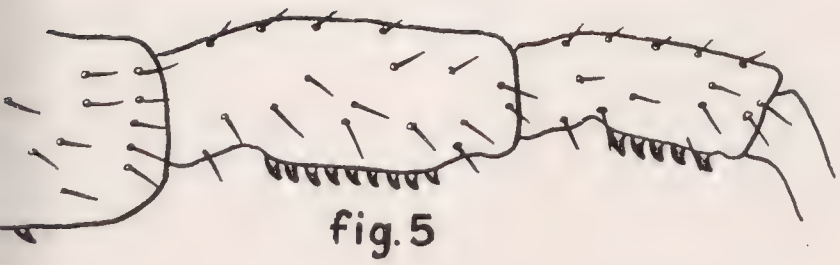

fig.5

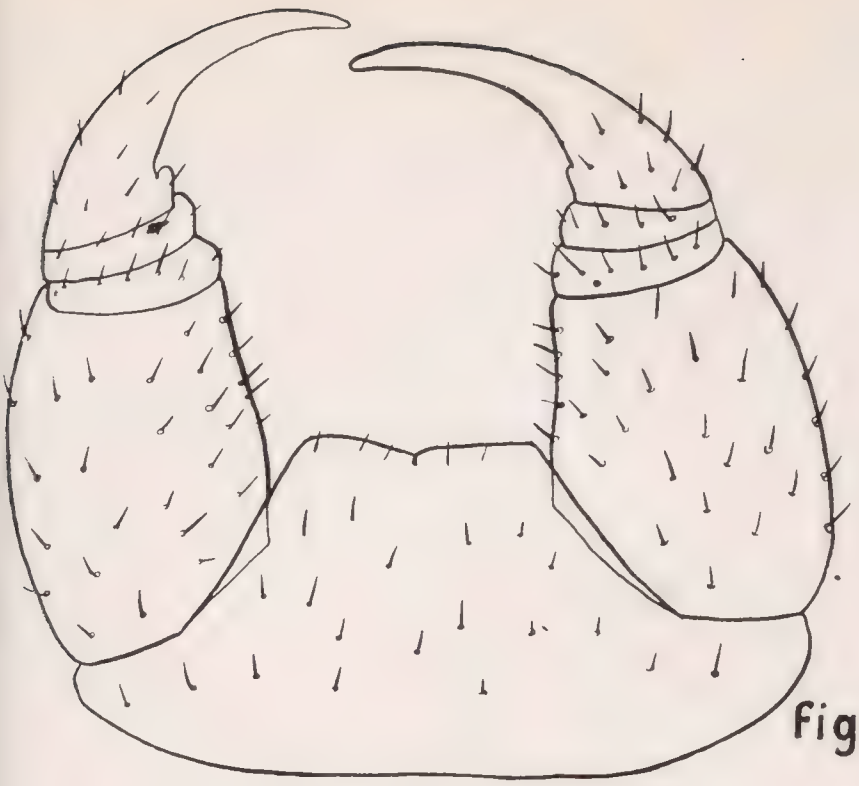

fig. 1

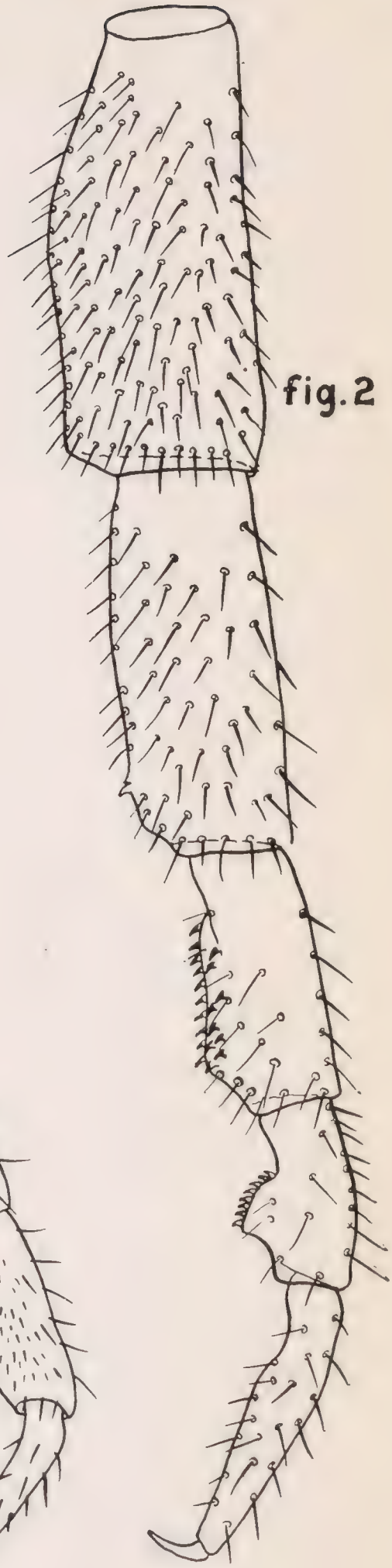

fig. 2

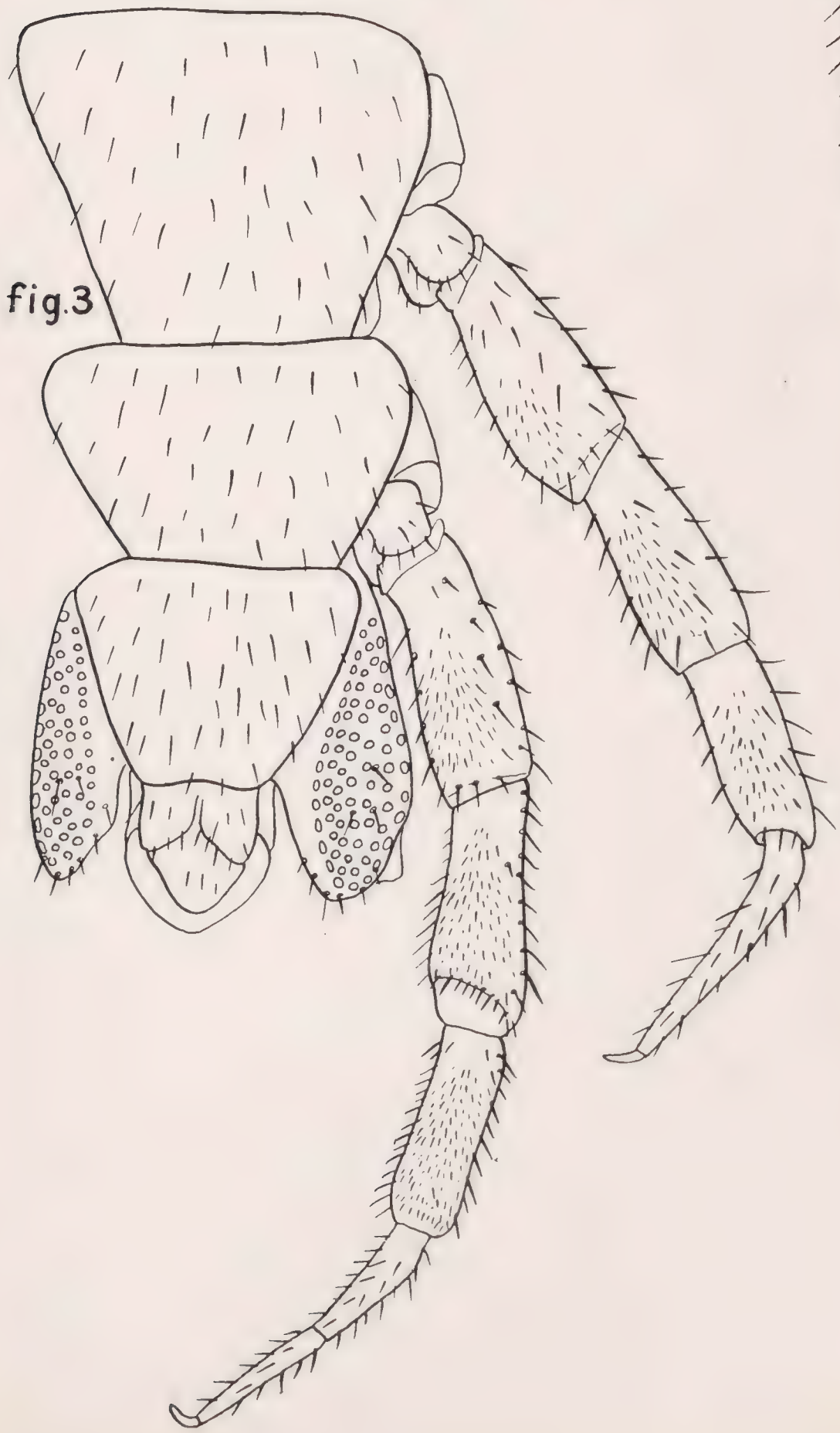

fig. 3

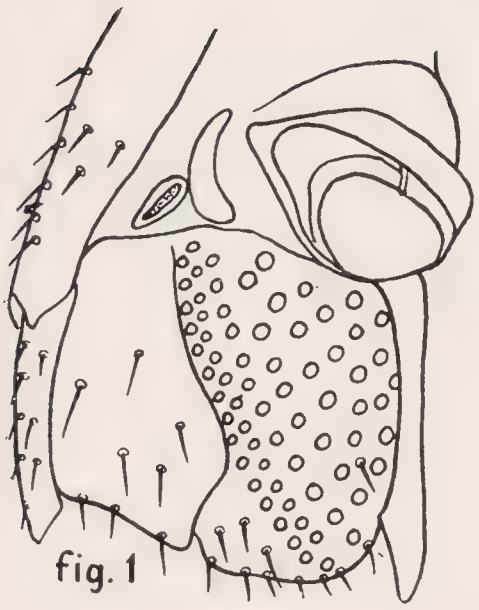

fig. 1

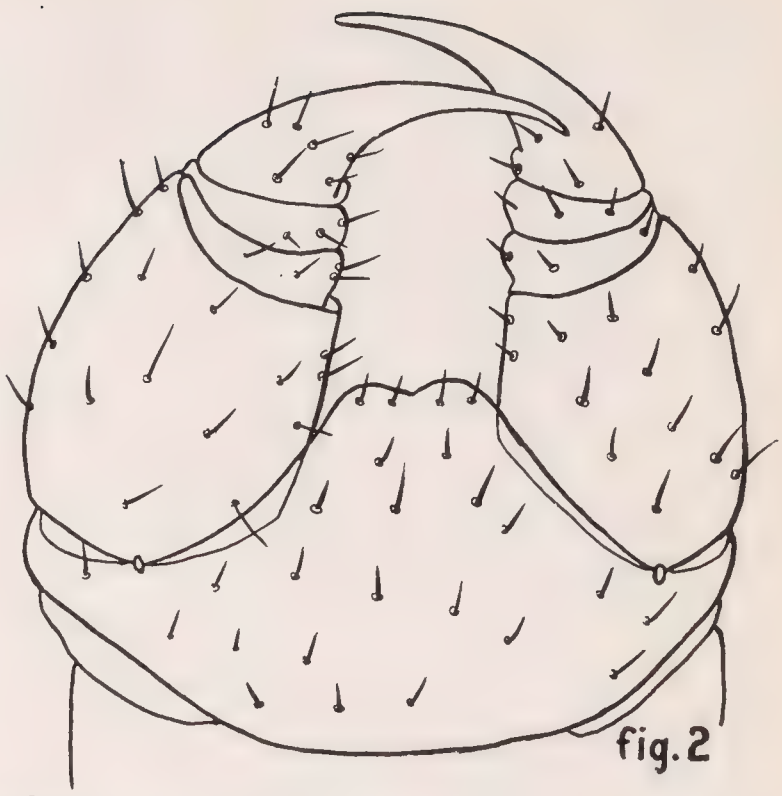

fig. 2

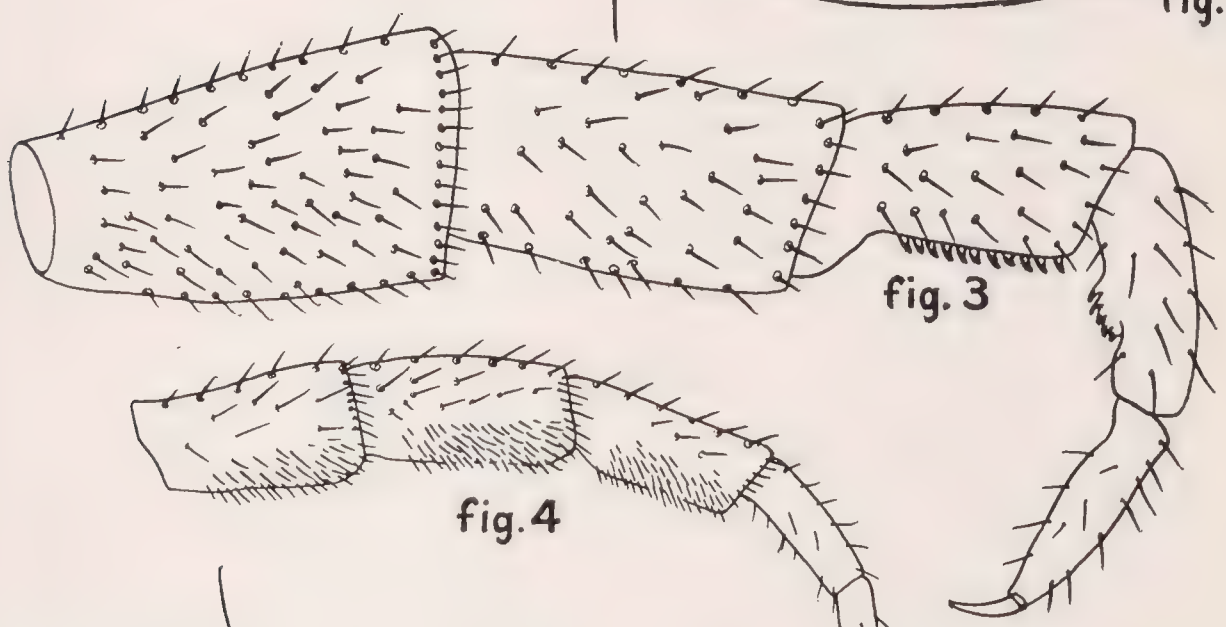

fig. 3

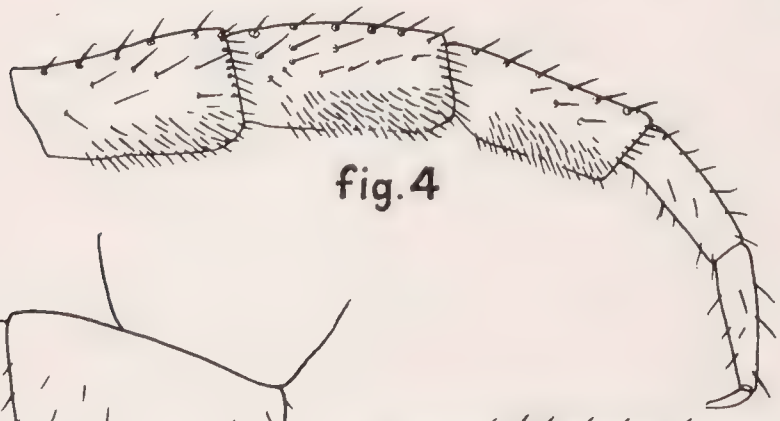

fig. 4

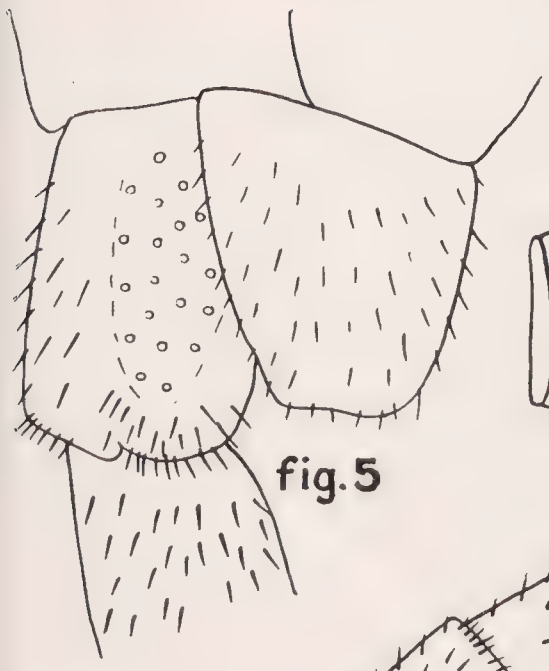

fig. 5

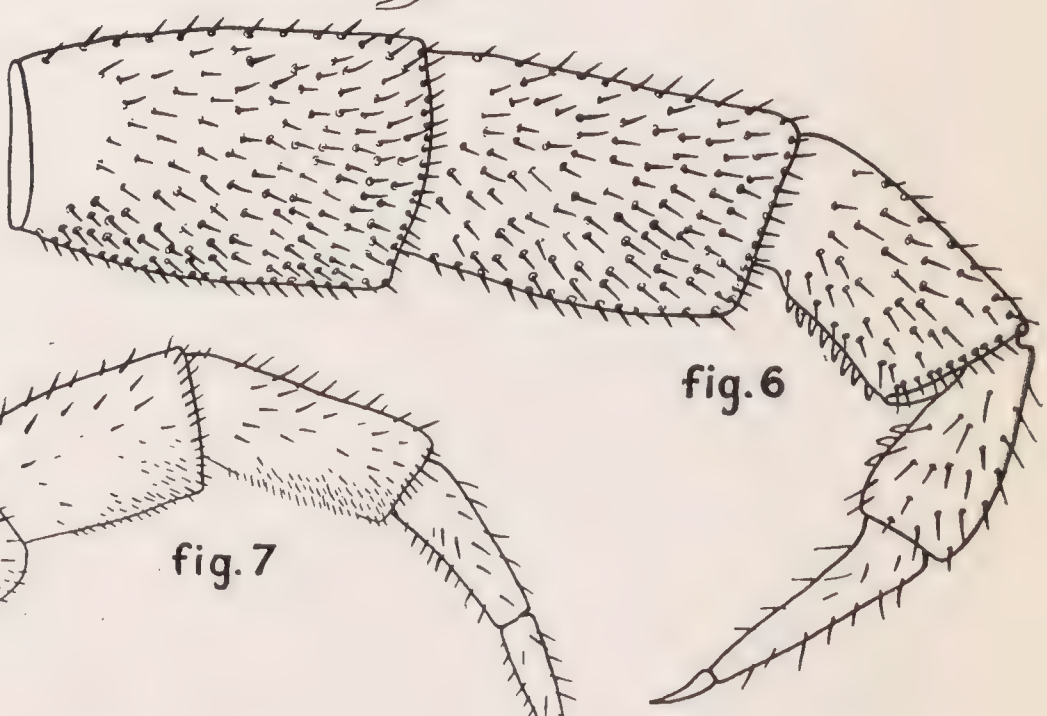

fig. 6

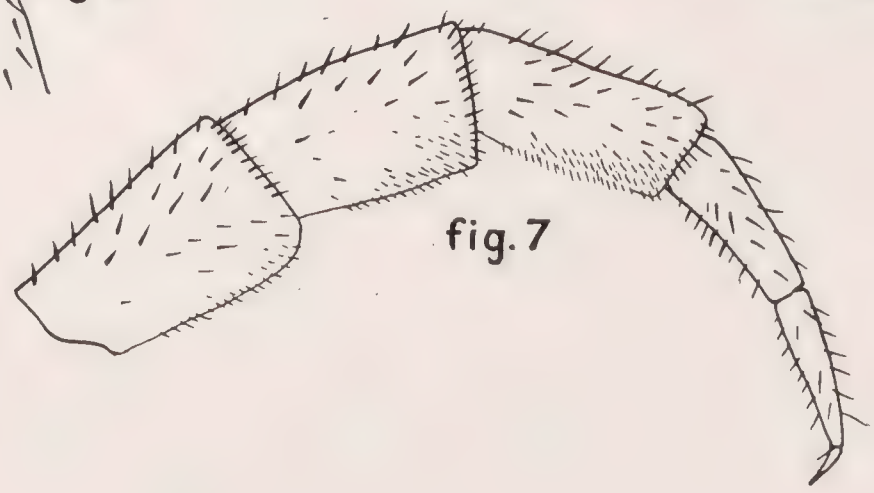

fig. 7

NEW ZEALAND DIXIDAE (DIPT.)

By A. L. Tonnoir, Assistant, Canterbury Museum.

The presence of some representatives of this family in New Zealand was first recorded by Professor P. Marshall[1], who, however, did not describe any species at the time. The first species, *Dixa campbelli*, was described by Dr. C. P. Alexander[2], who a little later gave the description of a second species, *Dixa otagensis*[3].

In the meanwhile I had found in New Zealand six other species, which I am describing hereafter, with the early stages of two of them.

The genus Dixa has sometimes been considered as belonging not to a proper family, but to a subfamily of the Culicidae, chiefly on account of the larvae, which show some affinity with those of Anopheles. However, the imago is so widely different, especially in its peculiar venation, that I think it is quite justifiable to leave it in a separate family.

In the light of our present knowledge, which has been somewhat increased by the forms found in this country, this family, compared to the Culicidae, is characterised by the more primitive structure of the antennae composed of 16 simple segments and of similar structure in both sexes; further by the absence of scales or conspicuous hairs on the wings or the body, by the shape of the wings, which are more rounded, and by the venation in which Sc does not reach the costa past the base of Rs which is much curved, Rs being composed of three branches or even of two only and *r-m* being placed either before or after the fork of Rs or also sometimes just on that fork; the branches of the fork of M are usually short and strongly divergent, and one of them may be partially missing; the branches of Cu are always strongly curved.

The genus Dixa has been up to now the only one comprised in the family, but the discovery of a new New Zealand form of Dixid, presenting a notably reduced venation, makes the creation of a new genus necessary to receive it, as the genus Dixa (comprising about 40 species in the world) is as a whole rather homogenous as far as the venation is concerned. However, in examining more closely all the species of this part of the world, I have come to the conclusion that it can be divided into two quite distinct groups.

The first one with antennae of moderate length, scarcely longer than the thorax; with the basal segments of the flagellum

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1 Trans. N.Z. Inst. Vol. XXVIII, 1896, p.222.
2 Ins. Insc. Menst. Vol. X, 1922, p. 20.
3 Ibid p. 147.

short, fusiform and well distinct from each other; with *r-m* placed before the fork of Rs; with the male hypopygium presenting a simple structure, the aedeagus not being developed into several pairs of hooks; with larvae provided with crowns of hairs on the dorsum of most of the abdominal segments and with armatures of spines present only on the sternites of the abdominal segments 5 and 6.

The second group comprises forms with elongated antennae, nearly as long as the body; with all the segments of the flagellum elongated, filiform and scarcely distinguishable from each other; with *r-m* placed at or after the fork of Rs; with the male hypopygium of complicated structure, the aedeagus presenting often several pairs of hooks; with larvae deprived of the peculiar crown of hairs on the dorsum of the abdomen but provided on different parts of the body with very long soft bristles, and presenting an armature of hooks on the abdominal sternites 5 to 7.

I already pointed out this division, at least as far as the imagines were concerned, in a former paper on the Australian Dixidae[1]; so far as I can ascertain from the available literature a similar division can be made among the American species, and I have no doubt that further study of the European species will also disclose the presence of these two groups. It is curious to note that they should be present side by side all over the world.

The first one is evidently the more primitive, the venation and the male hypopygium being less specialised, but on the other hand its larvae seem more specialised on account of their peculiar dorsal crowns of hairs which provide adherence to the surface film of the water. This aim is reached in the larvae of the second group by the large development of some bristles of the body, especially those of the prothoracic sternite and the last abdominal sternites. To my knowledge there is no structure similar to these crowns of hairs in dipterous larvae unless they be represented to a very limited extent by the dorsal hairs *en rosette* of the Anopheles larvae.

This more specialised type of larvae corresponding to a less specialised type of adults shows, once more, how insecure it is to base the phylogeny of a group on larval forms.

The distinction between these two groups is sufficiently marked to allow us to consider them as sub-genera. I propose to retain for the first and more primitive one the name of DIXA and to give to the second one the name of PARADIXA.

The new genus hereafter described: DIXELLA, seems to be an offshoot of the sub-genus DIXA, the structure of the male hypo-

[1] Proc. Roy. Soc. Tasmania 1923 p. 58-71

pygium and of the antennae being similar; its venation is more specialised by reduction, and consequently this new form does not teach us anything new concerning the phylogeny of this small family.

With a very few exceptions all the material on which the present study is based has been collected by myself; all the types are in the collection of the Cawthron Institute, Nelson, and a series of paratypes is deposited in the collection of the Canterbury Museum.

1. ADULTS.

The two genera can be easily distinguished as follow:—

1.—Rs. composed of three branches; fork of M_1 M_2, complete
DIXA Meig.

2.—Rs composed of only two branches; fork of M_1 M_2 incomplete
DIXELLA n. gn.

Genus DIXA.

Table for males and females.

1. Antennae relatively short, about as long as the thorax; the first joint of the flagellum fusiform, quite distinct from each other; male hypopygium apparently composed only of the forceps and simple anal valves, no distinct complicated aedeagus; transversal vein *r-m* placed distinctly before the fork of Rs. Sub-gen. DIXA 2

   Antennae relatively long, distinctly longer than the head and thorax together; the joints of the flagellum elongate, filiform and indistinct from each other; male hypopygium with the aedeagus and tergum provided with several processes and hooks; *r-m* placed at or past the fork of Rs. Sub-gen. PARADIXA 5

2. Species with nearly uniformly dark coloration; wing with an inconspicuous cloud on *r-m* or unspotted 4

   Coloration yellowish with dark markings or dark with a few yellowish parts; wings conspicuously spotted .. 3

3. Coloration yellow with blackish markings; wings with an elongated dark blotch on the proximal part of M, besides the one on *r-m*. *D. campbelli,* Alex.

   Coloration dark with a few yellowish parts; wings with 4 spots *D. philpotti,* n. sp.

4. Stem of R_{2+3} distinctly smaller than the half of R_2; the cloud on *r-m* scarcely distinct; fork of M_2 M_3 rather long, M_1 distinctly longer than the stem of this fork, larger species *D. otagensis*, Alex.

   Stem of R_{2+2} distinctly shorter than half of R_2, about equal to a third of that vein; M_1 shorter than the stem of M_{1+2}; smaller species *D. septentrionalis*, n. sp.

5. Wing membrane clouded only round vein *r-m* *D. neozelandica*, n. sp.

   Wing with the longitudinal veins seamed with brown in their distal part *D. fuscinervis*, n. sp.

Dixa campbelli Alex.

Insecutor Inscitiae Menstruus, Vol. X., 1922, p. 20.

As this description has been published in a periodical practically inaccessible to New Zealand students, I think it worth while to reproduce it here in extenso:—

"General coloration yellow, handsomely marked with dark brown; legs yellow, tip of the femora and tibiae darkened; tips of posterior tibiae enlarged; wings faintly grayish; a conspicuous dark brown blotch at *r-m* and another on vein M; *r-m* connecting with Rs before its fork.

"Male—Length, 2·8-3 mm.; wing 3·3-3·5 mm.

"Described from alcoholic material.

"Rostrum brown above, paler laterally and beneath; palpi pale brown. Antennae with the enlarged scapal segments dark brown, the flagellum a little paler, especially the basal segment. Head dark brown, paler beneath and on genae.

"Pronotum obscure yellow, dark brown medially. Mesonotum yellow, handsomely marked with dark brown; a broad, conspicuous stripe on either side; a narrower median stripe, broad in front and here indistinctly split by a pale vitta, narrowed behind (in some cases this abrupt narrowed portion subobsolete), extending to the scutal region where it covers the caudal margin of the slerite; scutellum light yellow, indistinctly margined with darker; postnotum dark brown. Pleura yellow, conspicuously striped and blotched with dark brown; mesosternum broadly dark brown, pale ventro-medially, more broadly so on prosternum; a conspicuous, longitudinal pleural stripe extending from behind the fore coxae to the mesepimeron, which is largely suffused; the ventral yellow stripe and the mesosternum is narrower than the brown stripe; two brown blotches on the dorsal portions of the mesepisternum; propleura dark. Halteres

pale, the knobs light yellow. Legs with the coxae yellow, the fore coxae infuscated; trochanters pale; femora yellow, the tips conspicuously dark brown; tibiae light brown, the tips conspicuously blackened; posterior tibiae swollen at tips and more extensively blackened; tarsi brown. Wings with a faint grayish tinge, the extreme base more yellowish; a large, dark brown blotch at *r-m,* suffusing the adjoining veins of the cord, interrupted at *m-cu*; a smaller brown blotch beyond mid-length of M; veins narrowly and somewhat indistinctly seamed with dark brown, more heavily along R_{4+5}; anal angle faintly clouded; veins dark brown. Venation: Sc_1 ending a short distance before the origin of Rs, Sc_2 far from its tip, Sc_1 alone nearly equal to the first section of Rs; basal section of Rs long, straight; *r-m* connecting with Rs far before its fork, the second section of Rs being longer than *r-m*; R_{2+3} gently arcuated; forks of M widely divergent; *m-cu* about equal to *r-m*.

"Abdomen brown, darker apically; basal sternites and lateral portions of the basal tergites obscure yellow.

"*Habitat.*—New Zealand (South Island).

"*Holotypemale,* Charteris Bay, Banks Peninsula, Canterbury, *Sept.* 4th, 1921 (J. W. Campbell).

"*Paratopotypes,* 6 males.

"The specimens were in small swarm over a stream."

To this good description there is only to be added that the antennae are not longer than the thorax, and that the first joints of the flagellum are fusiform and quite distinct from one another. The male hypopygium is of the type shown in fig. 10, the aedeagus being deprived of hooks or complicated armature, and the tergal parts of the genitalia being apparently composed of two fleshy and hairy lobes placed on each side of the anus; the claspers are somewhat more pointed than in fig. 10.

The female does not differ from the male.

This species seems to have a rather wide distribution, besides Banks Peninsula, it has been collected in Nelson in *Apr., Aug., Oct., Dec.*; Pokororo, *Dec.*; Waiho (West Coast), *Jan.*; Lake Brunner (West Coast), in the larval stage, *Feb.*; Christchurch, *July*; all these localities in the South Island; in the North Island I found it only in the vicinity of Wellington at Day's Bay, *Dec.*; and in Welton's Bush, *March.*

Dixa otagensis Alex.

Insecutor Inscitiae Menstruus, Vol. X., 1922, p. 147.

For the same reason as in the case of the preceding species I shall give here Alexander's description:—

"*Male*—Length, 3·6 mm.; wing 4·5 mm.

"Roostrum and palpi black. Antennae and head black.

"Mesonotum brown, the colour almost obscured by the very broad black stripes on the praescutal region; scutellum pale brown; postnotum black. Pleura black, the mesepimeron and the lateral slerite of the postnotum obscure brownish yellow, brightest ventral of the wing-root. Halteres brown, the extreme base yellow, the knobs darker. Legs with the coxae brown, the posterior coxae more yellowish; trochanters yellow; remainder of the legs black. Wings with a faint brownish tinge, more pronounced in the costal region; a brown cloud at the *r-m* cross-vein; veins dark brown. Venation: Sc_1 ending immediately before the origin of Rs; a little more than its own length beyond *r-m*; cell M_2 deeper than in *D. campbelli*.

"Abdomen, dark brownish-black.

"*Habitat*—New Zealand (South Island).

"*Holotype*—Male, Ben Lomond, Otago, Dec. 30th, 1921 (G. Howes).

"*Paratopotype*—Sex?"

I have several specimens before me that I refer to this species; four of them are coming from Queenstown, which is not very far from the type's locality, and one from Waiho on the West Coast; they were collected in January and February.

To the above description only a few remarks need be added.

The antennae are of the shorter type with the basal flagellar segments fusiform and quite distinct from each other. The cloud on *r-m* is exceedingly weak, scarcely noticeable at all in dry specimens; the venation is given in fig. 11. The hypopygium is of the type shown in fig. 10, but the branches of the forceps are a little more pointed.

This is the largest species of *Dixa* I know.

Dixa septentrionalis, n. sp.

Male—Thorax dull, uniformly brown, without trace of darker stripes; scutellum, head and abdomen nearly black, the latter with some grayish reflections in certain positions; stem of the halteres yellowish, also the coxae; the legs brown; the pubescens of the body completely dark. Wing slightly infuscated, no spots nor cloud on *r-m*.

Antennae of the shorter type, the first five joints of the flagellum fusiform and quite distinct from each other. Venation: Sc reaching the costa just a little before the origin of Rs; the

portion of the stem of Rs placed after *r-m* is a little longer than *r-m* itself; fork of R_2 R_3 much longer than its stem, R_2 being about the double of it; stem of the fork of M_1 M_2 one and a half times the length of M_1.

Hypopygium, side-pieces without appendages or processes, only with a moderately swollen lobe at the internal distal end; branches of the clasper cylindrical and regularly curved; aedeagus undistinguishable; anal valves in the shape of two simple hairy lobes.

Length—2·½ mm.; wing 3·½ mm.

Type from Te Aroha, 28th *Feb.*, 1923.

Paratopotypes—Five males, all collected on the rocks at the foot of a waterfall.

The female is unknown to me.

This species is very similar to the preceding one from which it differs, however, by: the smaller size, the complete absence of cloud on *r-m*, by the venation in which the stem of Rs is distinctly longer compared to R_1 (½ instead of ¼); the stem of M_1 M_2 is also notably longer than M_1 instead of being shorter; the structure of the hypopygium does not show much difference in the two species.

These differences seem to be constant, and I think it is right to consider these two forms as different species, although they might also be two races of one species each proper to each of both islands as is sometimes the case for other animal forms of New Zealand.

Dixa philpotti, n. sp.

Female.—Head with its appendages brown; mesonotum yellowish orange with three dark dull stripes well separated from each other; scutellum yellow, postnotum brown with a faint yellowish marking above the posterior coxae, the sternum also slightly yellowish; abdomen dull brown; halteres yellow; coxae yellowish; the femora somewhat infuscated on their middle and with a subterminal ring of distinctly lighter colour, their tip dark brown; tibiae and tarsi brown. Wing strongly and intensively marked with brownish; the spot on *r-m* large and extending to the base of Rs, another roundish spot on the stem of R_{2+3}; an elongated marking bordering R_{4+5}; a spot on the middle of cell R; M_1 and the two branches of Cu are also distinctly seamed with brown, whereas the base of the wing offers also a brown suffusion along the base of Cu and on A.

Antennae relatively short, the first five segments fusiform and quite distinct from each other. Hind tibiae conspicuously

swollen at tip. Venation: Sc reaching the costa distinctly before the origin of Rs, *r-m* placed on Rs at a greater distance from the fork than its own length; stem of R_{2+3} forming a wide arc and provided with a small stump of a vein towards its middle; fork of M relatively short; extremity of the anterior branch of Cu much curved.

Length of wing $3\frac{1}{2}$ mm.

Type—Nelson, *Dec.* 15th, 1922.

Paratypes—All females, from the same locality on *Oct.* 18th and *Dec.* 5th; also from Mount Arthur, *Dec.* 24th.

Each time this species was collected by sweeping the plants along mountain creeks with a much swifter flow of water than in those where the *Dixa* larvae usually breed.

Dixa neozelandica n. sp.

Male—Head shining black, palpi and antennae brown, metanotum mostly dark brown, the three longitudinal stripes being more or less fused together anteriorly and leaving only the shoulders and sides yellowish-ochraceous; the space in front of the scutellum dark ochraceous; the anterior part of the metanotum is dull but its posterior part is shining. Pleurae dark, velvety with a somewhat lighter band extending backwards from the base of the front coxae; scutellum, postnotum and abdomen brown; halteres ochraceous; tip of front coxae, the whole of the posterior ones and the legs ferrugineous with the tip of the femora and the posterior tibiae dark. Wings subhyaline with a single, somewhat weak spot on *r-m,* which extends on the fork of Rs.

Antennae nearly as long as the body, the segments of the flagellum filiform, elongate and scarcely distinguishable from each other. Palpi with the following formula: 2-5-5-8 (as in most of the New Zealand species). Venation: Sc reaching the costa nearly in front of the origin of Rs; stem of R_{2+3} half as long as R_2; *r-m* placed after the fork of Rs; stem of M_1 M_2 about as long as its fork.

Hypopygium (fig. 7)—Side pieces with an internal basal process in form of a rather long undulated spine; claspers with a more or less triangular end, their internal side provided with spinules and its base with a little process carrying two small spinules at the end; four pairs of processes belonging to the aedeagus or to the tergum, the lower ones (in the twisted position of the hypopygium) are in shape of hooks with a few very short bristles on the inferior side; the two median processes in form of

elongated spines; the most internal pair in form of rather blunt little hooks; all this pieces are difficult to see, and it needs a careful preparation of the genitalia to display them.

Length of wing, 3 mm.

Female similar to the male; the genital lamellae very little developed, and offering no special characters.

Type—Aniseed Valley (Nelson), *Mar.* 21st, 1922.

Paratypes—Nelson, *Dec.*; Purau Creek (Banks Peninsula); Ohakune, *Mar.*; Nihotapu (Auckland), *Feb.*

This species is, with the following one, the most frequently met with along small rivulets with a moderate flow of water. Its larval stage is described below.

Dixa fuscinervis, n. sp.

Male—Head dark shining, antennae and palpi lighter brown, proboscis somewhat yellowish. Mesonotum mat, dark brown, the three longitudinal stripes being fused in front; shoulders and sides narrowly ochraceous, space in front of the scutellum dark ochraceous; pleurae velvety brown with a slightly marked yellowish stripe extending backwards from the anterior coxae; the sternum more or less yellowish; scutellum and postnotum brown. Halteres yellow, abdomen brown, the anterior part of the segments lighter; tip of anterior coxae, the whole of the posterior ones and the legs ochraceous, only the tip of femora and tibiae dark.

Wing with a slight brownish tinge, a large conspicuous spot on Rs extending downwards on *r-m* and upwards on the base of R_{2+3}; in the distal part of the wing all the longitudinal veins are conspicuously bordered with brown, also the proximal part of Cu and the edge of the anal lobe.

Antennae and palpi as in preceding species. Venation: Sc ending in costa in front of the origin of Rs; stem of R_{2+3} very much curved at its base and only by one half shorter than its fork.

Hypopygium (fig. 6)—Side-pieces without internal basal processes, only a little one at the base of the claspers ending in a few short hairs; claspers with a pointed end and a rounded lobe at the internal side which carries a few spinules; four pairs of processes on the aedeagus, the inferior ones short cylindrical with a couple of setae at the end, the other processes in form of more or less twisted spines, the two median ones much approximated.

Length of wing—$3\frac{1}{2}$ mm.

Female similar to the male.

Type—Nelson, *Sept.* 5th, 1922.

Paratypes--Purau Creek (Banks Peninsula), *Feb.*; Kaikoura, *Feb.*; Waiho, *Jan.*; Reefton, *Jan.*; Lake Brunner, *Feb.*; Nelson, *Dec.*

This seems to be the most abundant species, its larvae can be found practically the whole year round.

Genus Dixella, nov. gen.

This genus is characterised by the radial sector having only two branches. In the single species known, *D. minuta* n. sp., which is the genotype, the basal half of M_2 is missing, but this may be only a specific character.

D. minuta, n. sp.

Male—Body completely black, head and thorax shining, its pubescens very short and inconspicuous, abdomen dull somewhat velvety; halteres yellowish, also the coxae and the legs with the exception of the tip of the femora, tibiae and the end of the tarsi which are blackish; wing hyaline unspotted, its base and anterior border yellowish.

Antennae about as long as the head and thorax together, 16 jointed, the second joint swollen as in Dixa, the seven first segments of the flagellum more or less fusiform and fairly distinct from one another, the following ones filiform. Palpi, 4 segmented: 1st smallest, 2nd and 3rd sub-equal, 4th about twice as long as the preceding one.

Legs as in Dixa, the hind tibiae swollen at the tip; posterior metatarsi with a spine at their base below; claws serrated.

Venation: Sc ending in costa somewhat before the middle of the wing and also well before the origin of Rs; fork of Rs long, basal half of M_2 obliterated.

Hypopygium as shown in figs. 9 and 10, no appendages on the base of the side-pieces and the structure of the aedeagus indistinct.

Length of wing—$2\frac{1}{2}$ mm.

Holotype—Nelson, *Oct.* 18th, 1923, obtained in sweeping with the net some low shrubs in a wet part of the track along the "Reservoir" creek.

LARVAE.

The larvae of three of the above species are known to me; they are found practically the whole year round in the small rivulets of clear and moderately swift running water.

They can be distinguished from each other in the full grown stage as follows:—

Tergum of the abdominal segents each with a conspicuous crown of hairs. Ventral abdominal armatures of hooks present only on the segments 5 and 6. Sub-gen. DIXA

Stigmatical plate as in fig. 12b; the caudal appendage black not much longer than the lateral plates *D. campbelli*, Alex.

Abdominal segments without crown of hairs on the dorsum; ventral abdominal armature of spines present on the segments 5 to 7. Sub-gen. PARADIXA

Lateral edge of the basal part of the lateral plates with two conspicuous teeth (fig. 12d). *P. neozelandica*, Tonn.

Lateral edge of this plate without teeth (fig. 12c). *P. fuscinervis*, Tonn.

Dixa campbelli, Alex.

Size of full grown larva, 6½ to 7 mm.

Coloration yellowish green with indefinite blackish markings; head ochraceous bordered posteriorly with black, especially on the sides and ventrally.

Antennae with the usual microscopical triangular spinules and with one small external bristle inserted not far from the extremity. Mouth parts as usual, the two hair brushes of the labrum well developed but not much longer than the antennae; mandible with only one terminal internal tooth and one relatively long external terminal bristle; maxillae triangularly elongated outwards and as long as their palpi that do not carry bristles but only the microscopical triangular spinules similar to those of the antennae; mentum not denticulated, ending in a rather sharp point.

The hair of the body little conspicuous; those of the border of the prothoracic sternum only one-third as long as the head, and arranged on each side of the centre in rows of four, and a little behind each of the most internal ones there is a pair of similar bristles inserted at the same point.

Abdominal prolegs of segments 1 and 2 subequal to each other and of the usual pattern; armatures of spines of the segments 5 and 6, composed of two groups of 6 backward pointing spines surrounded with fine short hair at their base, and below which is another row of six spines closely adpressed against the body and looking as if they were imbedded in the integuments.

Structure of the end of the body as in fig. 12b, the spiracles rounded, between them four little tufts of branched hairs; the lateral plates are not connected between them at the base; the caudal appendage is black, relatively short, not reaching much over the end of lateral plates; its end is conical and carries moderately long plumose bristles; before the anus there are six small bristles, three on each side.

Pupa.—The pupa of D. campbelli does not show any feature that would differentiate it readily from the others of the genus. The breathing horns are as shown in fig. 12e, in shape of a four-sided funnel, the edge of which is finely crenelated; the spiracle is opening at the bottom of the funnel, which is open by a slit on the dorsal side.

The pupation lasts only three or four days.

Dixa neozelandica, Tonn.

Size of full grown larva, 6 to 7 mm.

Coloration of the body as usual without any conspicuous markings, head ochraceous with a black posterior margin, except on the fronto-clypeus and on the middle of the underside. Antennae with the microscopical triangular spinules replaced to a certain extent by very small hairs on the upper distal half of these organs; one small straight bristle on the middle of their external side.

Mouth parts as in preceding species, the mentum rounded without indentation. The body carries some very long black bristles; those placed at the anterior border of the prosternum are arranged in the following order: 1.1.1.4.1.–1.4.1.1.1., they are very long and reach well over the head; there is also one pair on the underside of the abdominal segments 5 and 6, and four on the 7th, which are placed near the armatures of spines. Each row of these armatures comprises from 7 to 8 strong spines, underneath which is another row of slender but equally long spines, the rows of the 7th segment contain only 5 to 6 spines. The 8th segment carries underneath 2 pairs of long black bristles, and the 9th 3 pairs inserted just before the anus. The 6 strong bristles of the caudal appendage are very long but inconspicuously plumose.

The structure of the end of the body as shown in fig. 12a; the spiracles are round; between the spiracular plates there is a V-shaped chitinous piece, each branch of which is surmounted by three tufts of branched hairs; the lateral plates are connected between them at their base by a moderately chitinised plate covered with microscopical pubescence. The edge of the

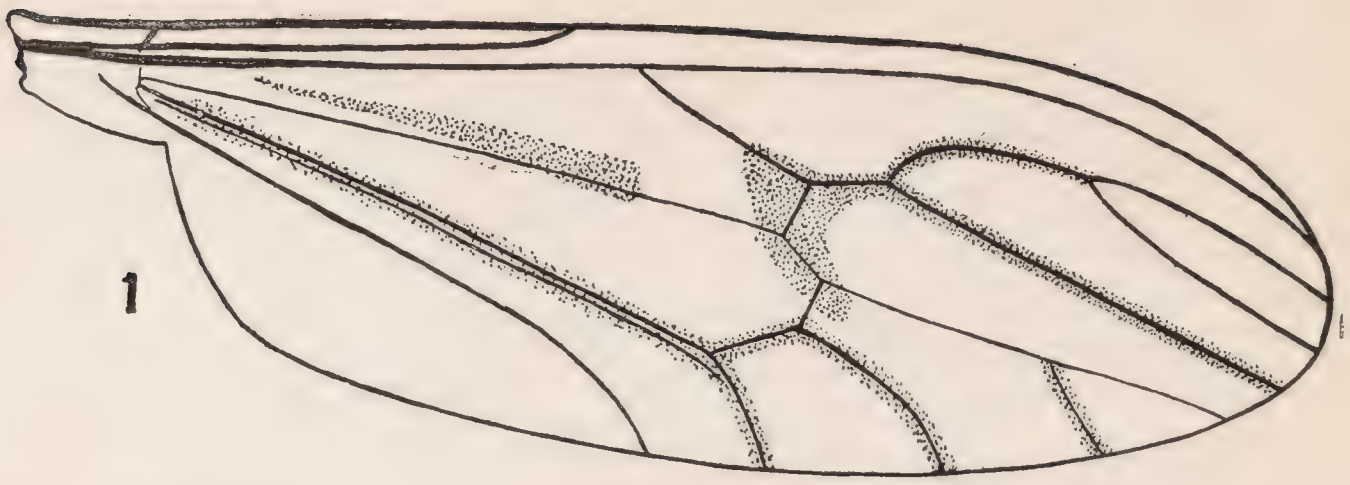
basal part of the lateral plates when seen from the side shows a row of small hairs ending with two conspicuous dark teeth. The ferrugineous caudal appendage reaches well over the end of the lateral plates.

Dixa fuscinervis, Tonn.

The larva of this species agrees in every respect with the one of the preceding species, the only apparent difference is to be found in the absence of the two teeth on the edge of the basal part of the lateral plates (fig. 12c).

Explanation of Plates.

Plate xxxviii.,	fig. 1	...	Wing of *Dixa campbelli* Alex.
	fig. 2	...	,, ,, *neozelandica* n. sp.
	fig. 3	...	,, ,, *philpotti* n. sp.
	fig. 4	...	,, ,, *fuscinervis* n. sp.
	fig. 5	...	,, ,, *septentionalis* n. sp.
Plate xxxix.,	fig. 6	...	Hypopygium of *D. fuscinervis* n. sp.
	fig. 7	...	,, ,, *D. neozelandica* n. sp.
	fig. 8	...	Wing of *Dixella minuta* n. sp.
	figs. 9 and 10		Hypopygium of *Dixella minuta* n. sp.
Plate xl.,	fig. 11	...	Wing of *Dixa otagensis* Alex.
	fig. 12A	...	End of body of larva of *D. neozelandica.*
	fig. 12B	...	,, ,, ,, *D. campbelli.*
	fig. 12C	...	Side of lateral plate of *D. fuscinervis.*
	fig. 12D	...	,, ,, ,, *D. neozelandica.*
	fig. 12E	...	Breathing horn of pupa of *D. campbelli.*



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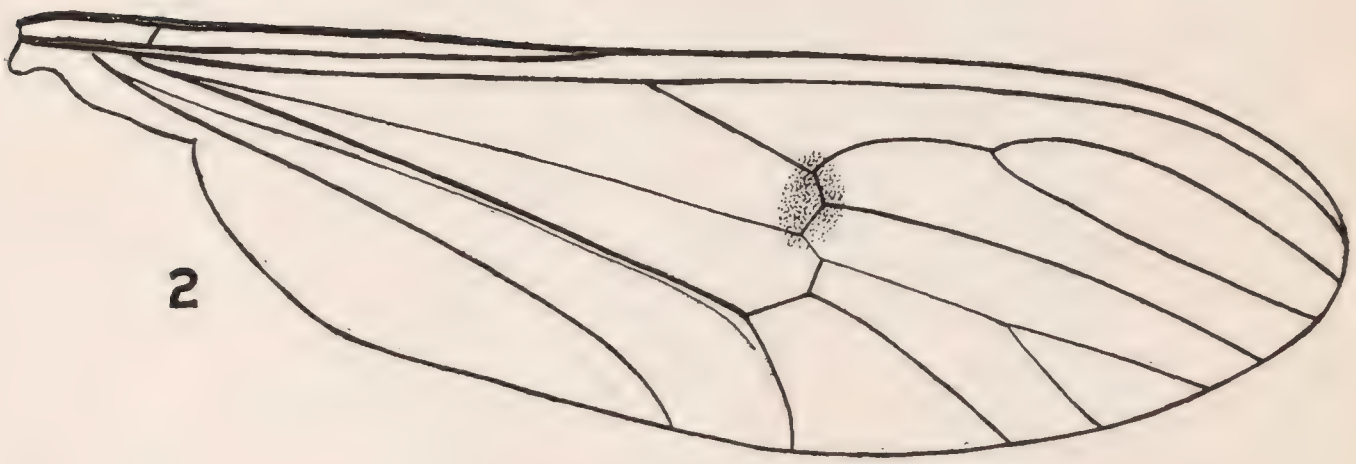

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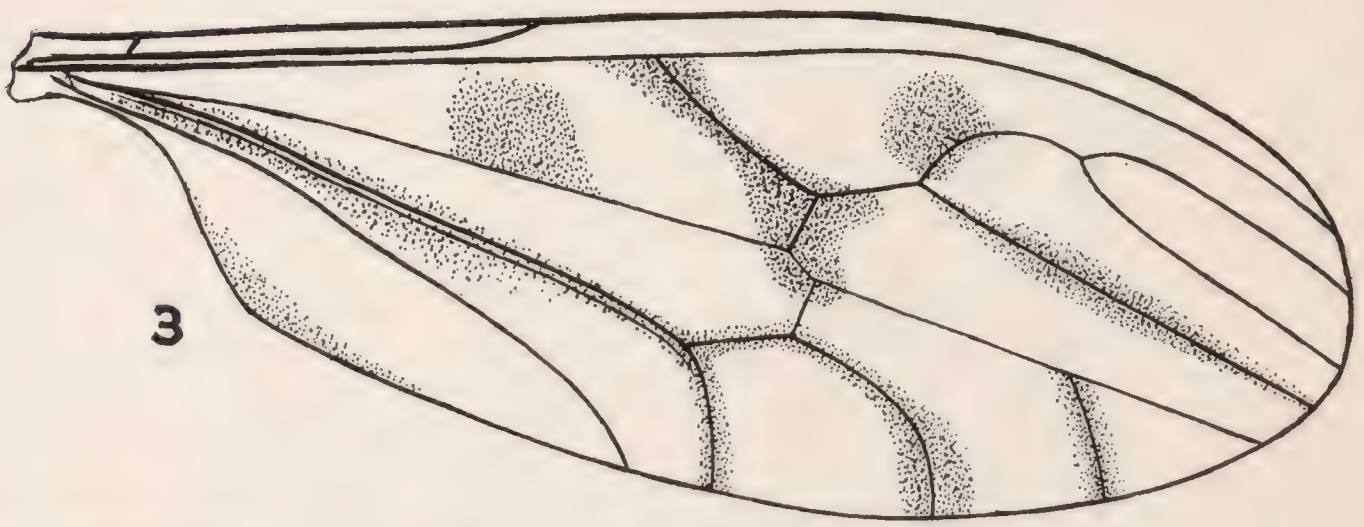

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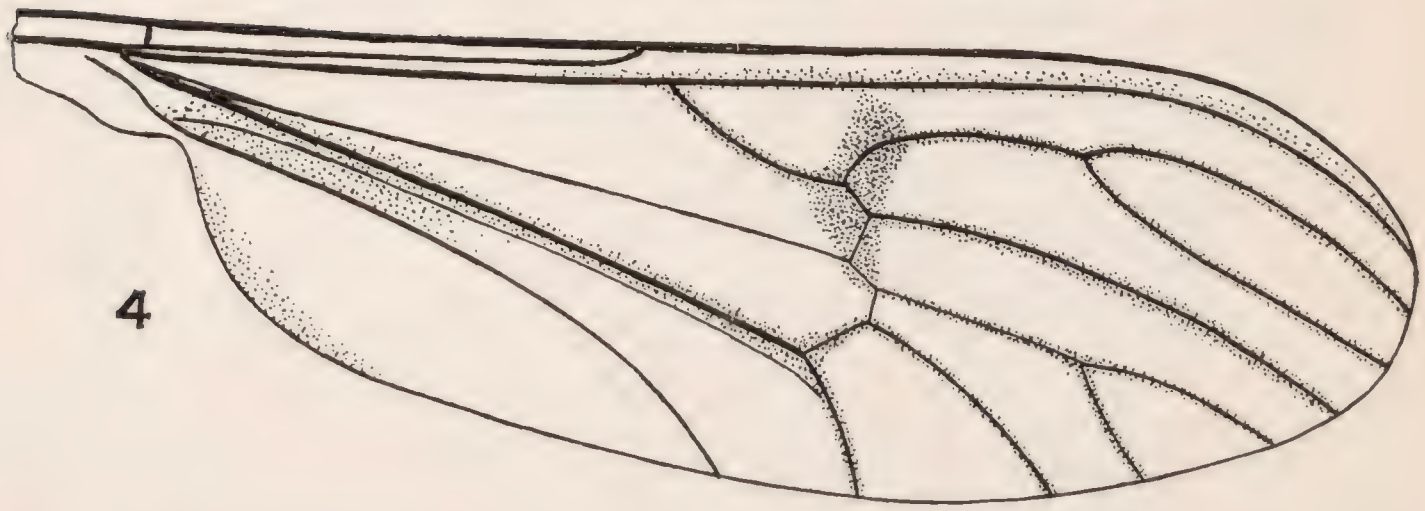

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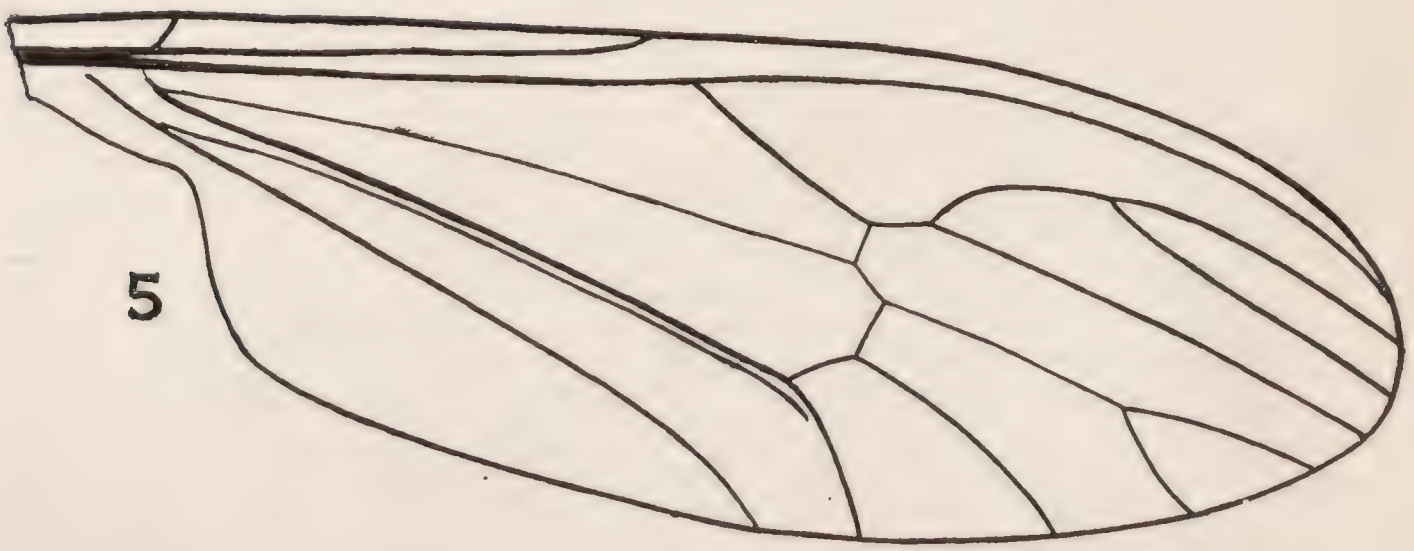

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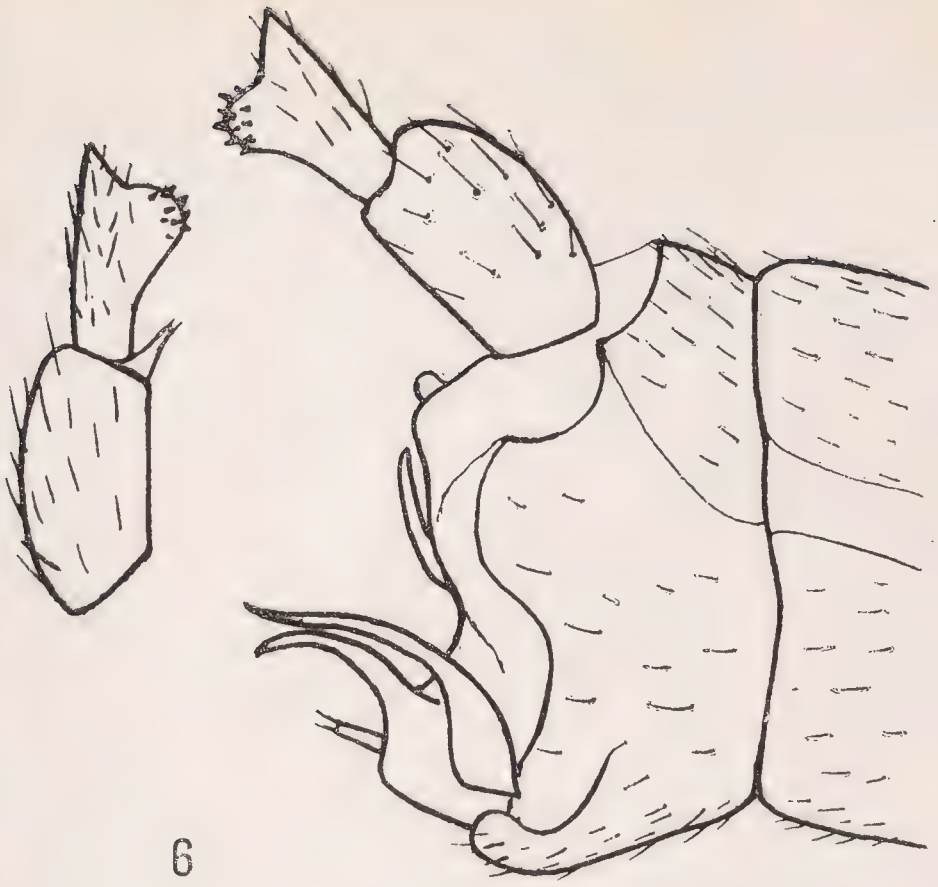

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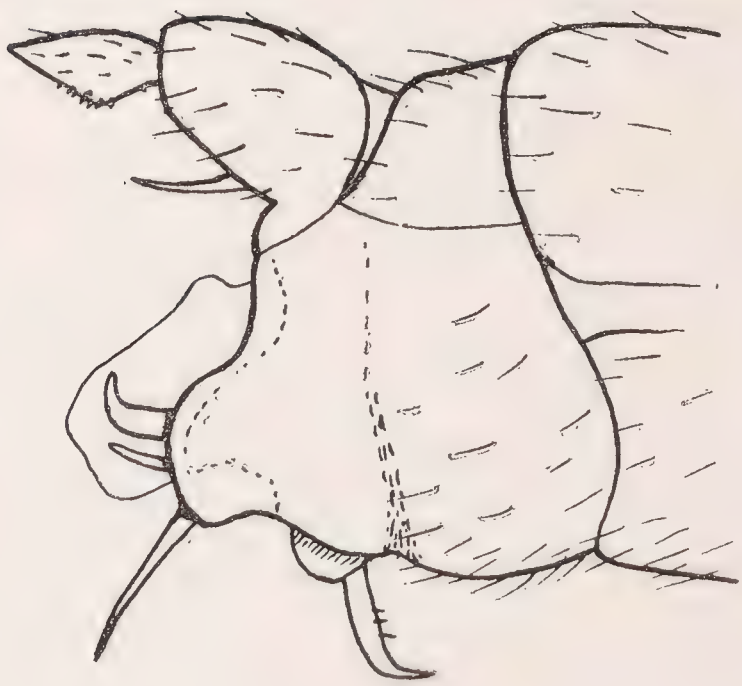

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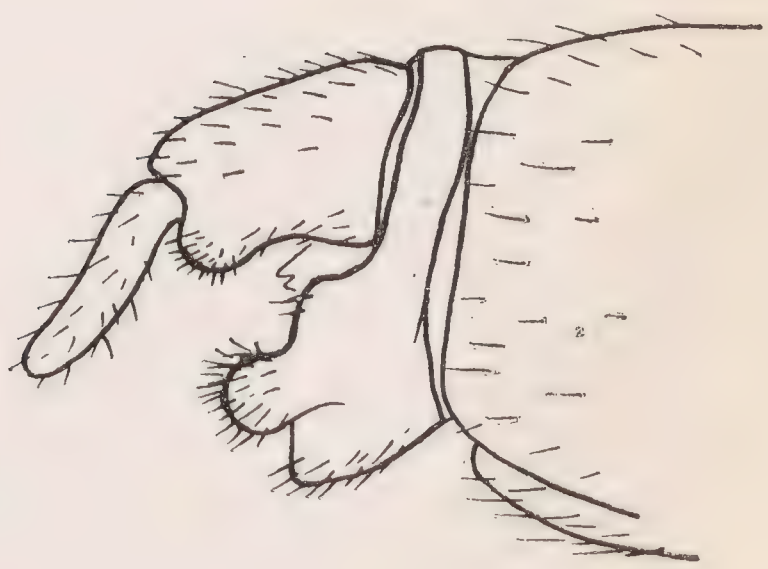

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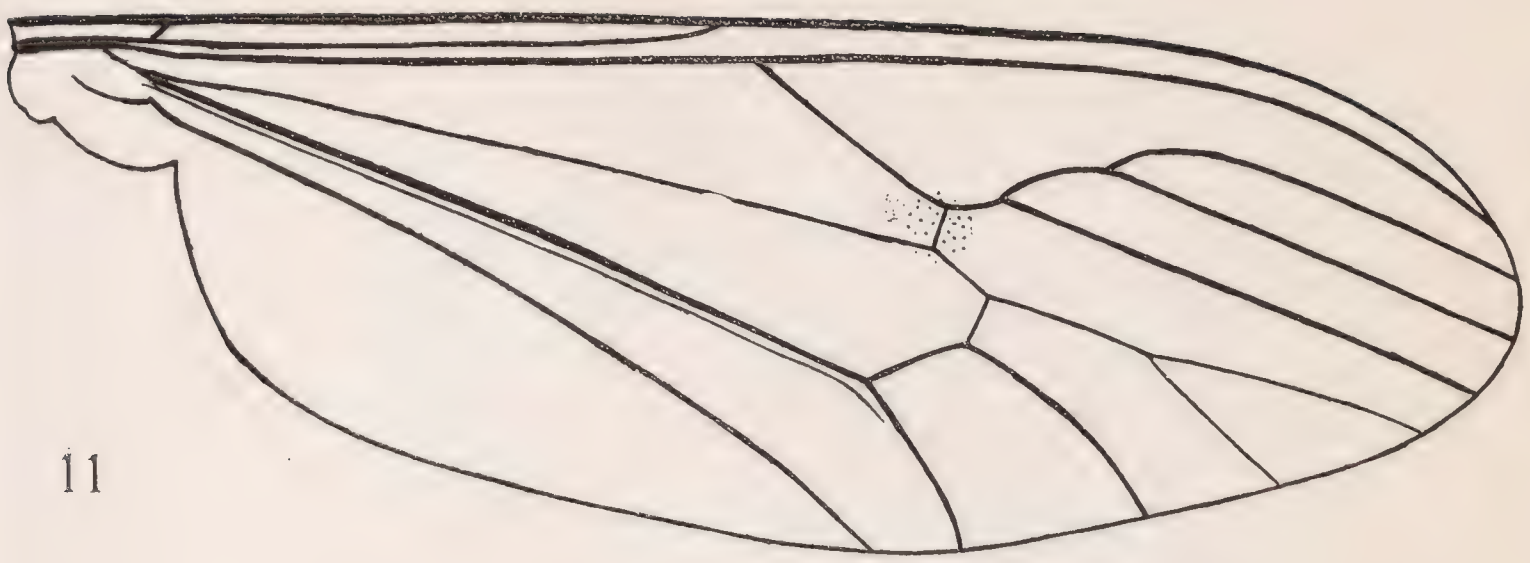

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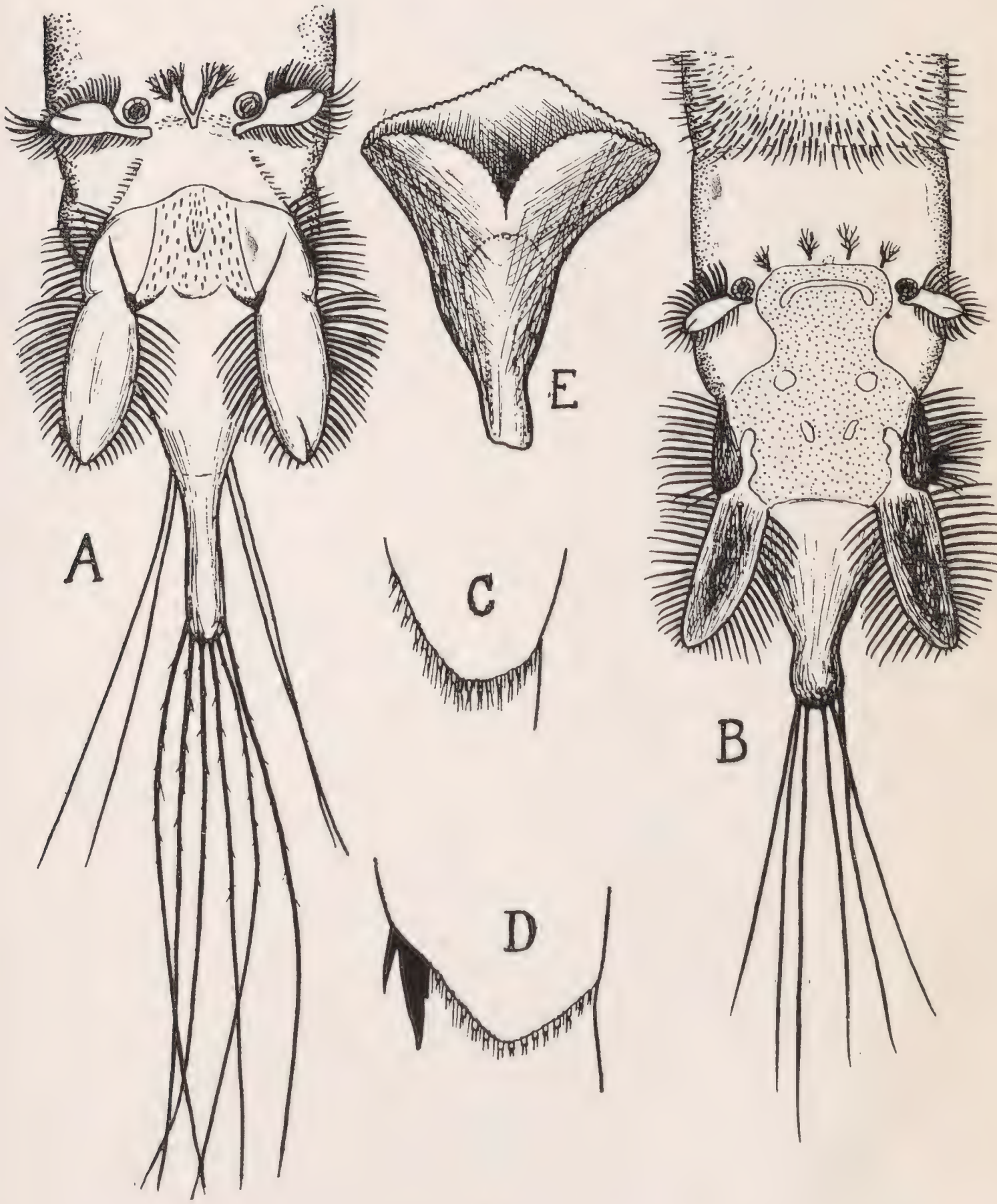

HAASTIA GREENII HOOK. F: WHAT IS IT?

By Professor A. Wall, Hon. Curator of the Herbarium.

Haastia Greenii, Hook. f., is the name given by Hooker to a plant which was collected by the Rev. W. S. Green at about 6,500 feet, on the ridge which runs from his fifth camp (now, approximately, the Ball Hut) up to the Ball Pass on the Mount Cook Range. This was on February 25th, 1882. No flowering specimens were collected, and the plant has never been recorded since that time. The species was published by Kirk (*Students' Manual,* p. 296) from Hooker's MS. account. No specimen exists in Kirk's herbarium, and the only specimen he saw was that now in the Canterbury Museum.

With the object of rediscovering and collecting this species the writer visited the locality on January 22nd, 1924. In spite of a rather late start the whole of the ridge from about 5,000 feet to the upward limit of vegetation near the Ball Pass, about 7,000 feet, was closely examined, and all the plants seen were listed. These included nothing very rare, and no "*Haastia Greenii*" was obtained. The writer conjectured that it had perhaps been eaten out by chamois, and some of the Mount Cook guides thought this not unlikely, but on his return to Christchurch he became convinced, on a closer examination of the specimen in the Herbarium in the Canterbury Museum, that a mistake had been made, and that the plant named *Haastia Greenii* was really only *Raoulia eximia,* a plant which he had actually listed on the Ball Spur.

The Canterbury Museum specimen is a single very small branch about 1½ in. long. It is labelled in the handwriting of Sir Julius von Haast: "*Haastia Greenei,* Hooker fil. Collected by Rev. Green during his ascent of Mount Cook."

It resembles so closely an old branch of *Raoulia eximia* that it is impossible to perceive any difference at all. It has the peculiar reddish-brown colour which long-dried specimens of this *Raoulia* always assume in the writer's experience. Specimens, for example, collected by Haast in 1861, and by Buchanan rather later, have been examined by him; they have this exact colour, and agree exactly with the specimen of *Haastia Greenii* in the most minute particulars.

The Canterbury Museum specimen was examined in 1913 by Mr. D. Petrie, the eminent botanist, who expressed his opinion that "the plant seems to me to be a species of *Raoulia*, and not a true *Haastia.*" He also expressed his surprise that Hooker

"should have described the plant as distinct from such very imperfect material as he avowedly had available." (Petrie MS.).

The descriptions of *Haastia Greenii* and *Raoulia eximia* exactly tally. The leaf is all we have to go by. Cheeseman (*Manual*, p. 332) says of *Raoulia eximia*:—"Leaves—imbricated all round the branch in many series, $\frac{1}{8}$-$\frac{1}{5}$ in. long, linear-obovate or linear-cuneate, rounded at the tip, membranous, bearing on both surfaces towards the tip a dense tuft of straight white hairs which project beyond the leaf and entirely conceal it." Hooker (as cited by Kirk: *Students' Handbook*, p. 296) says of *Haastia Greenii*:—"Leaves densely imbricating all round the stem, $\frac{1}{5}$ in. long, obovate-cuneate, rounded at the tip, thickly clothed on both surfaces with long straight hairs which meet beyond the margin and completely hide the leaves."

These seem to the writer to be merely two descriptions of the same plant. Having reached these conclusions he communicated them to the authorities at Kew, and asked that the type of *Haastia Greenii*, if it were there, should be compared with specimens of *Raoulia eximia* in order to bring his conclusion to the test.

In reply the following letter was received:—

[COPY.]

Royal Botanic Gardens,
Kew, Surrey,
25th March, 1924.

DEAR SIR,—In reply to your interesting letter of 4th Feb., I have had a very careful search made in the Herbarium with regard to *Haastia Greenei* Hook. f., and though we cannot give you an absolutely definite answer, the facts as far as they go support your conclusions.

We can find no specimen labelled *Haastia Greenei* in the Herbarium. In looking up the bound volumes of the Hooker Correspondence, however, we find there is a letter from the Rev. W. S. Green, dated May, 1882, referring to five plants sent to Kew for naming. One of these was reported on as "*Haastia sp.* (barren)." In June of the same year another letter was received from Mr. Green from Ireland, expressing his thanks for the honour of having a plant named after him. This letter is endorsed in the margin in pencil "*Haastia Greenii Mt. Cook.*" In looking through the covers of *Raoulia eximia*, though no specimen bearing this name is present, there is a sterile plant

from Mr. Green labelled "Mt. Cook, 1882." This is undoubtedly a plant of *Raoulia eximia,* and it seems quite likely that it may be the original of *Haastia Greenei* which was never written up.

I do not think it likely that the type specimen will be found in any other herbarium, and therefore if this plant is not the type it has probably been lost. You, therefore, have a fairly clear field, and I hope this will reach you in time to incorporate your conclusions in the second edition of Mr. Cheeseman's *Manual.*

Yours faithfully,

(Signed) ARTHUR W. HILL,
Director.

PROFESSOR A. WALL,
Canterbury College,
Christchurch, New Zealand.

This very interesting communication plainly puts the writer's contention beyond doubt.

It would now seem to him the proper course that the species *Haastia Greenii* should be deleted from that genus and the name added as a synonym to *Raoulia eximia* in any future flora of New Zealand, and that this change should be made, if possible, in the forthcoming new edition of the *Manual* of the late Mr. T. F. Cheeseman.

There remains one question of interest—how is it possible that so sound and cautious a botanist as Sir Joseph Hooker could have been brought to think that Green had discovered a new species? Is it not strange that he committed himself to this opinion in the absence of any flowering specimen?

A consideration of all the circumstances may help us to answer the first, at any rate, of these questions. It is clear from Green's account (*High Alps of New Zealand,* 1883, pp. 207, 234–5) that his observation of the high alpine flora of the New Zealand Alps was almost entirely confined to the one day when he traversed the Ball Spur. His second attempt upon Mount Cook was by way of the ridge which separates the Ball Glacier from the Hochstetter (now called Anzac Ridge), and this offers very little vegetation of any kind. During his third, and most successful, attack, by way of the Haast Ridge, Green was impressed by the "profusion of Alpine flowers," but on both this and the second attempt he and his guides would be too busy to pay much attention to anything beyond the business in hand.

He made no further ascents in the Mount Cook region, and after a brief abortive attempt upon Mt. Earnslaw, when an alti-

tude of about 5,000 feet only was reached, he saw no more of the New Zealand Alps.

Green was interested in the flora, observed pretty carefully, and picked up the names of the commoner flowers very quickly, as his book clearly shows, but he had apparently no special facilities for collecting or preserving plants, and indeed the difficulties to be surmounted before a starting-point even could be reached were so serious that anything of that kind was out of the question. It is probable therefore that the few plants he brought away were not very carefully packed or attended to.

Raoulia eximia is so striking and curious a plant that he would be tempted to take some of it. If, however, pieces are detached without due care from the main plant the branches are apt to fall asunder, and their appearance is then very different indeed from what it is when they are compressed and compacted into the hard mass of the "Vegetable Sheep," for in their natural state their tips only are visible, and these are hardly distinguishable from one another in the uniform smooth "woolly" surface.

It is possible, then, that by the time Green reached England on his return from Mount Cook his specimens were in this state, and Hooker was deceived by them into the supposition that the branches were those of a loosely tufted plant like *Haastia recurva* or *H. Sinclairii* instead of the component parts of so strange an aggregate as *Raoulia eximia*. Even then it remains surprising that in the absence of flowers he should have pronounced the species distinct, as *Raoulia eximia* must have been very well known to him.

The writer acknowledges his obligations to A. W. Hill, the Director of the Royal Botanic Gardens, Kew, for his assistance in elucidating the history of *Haastia Greenii*; to Mr. D. Petrie, whose suggestion as to the true identity of the Canterbury Museum specimen proved most helpful, and to Dr. L. Cockayne for the information contained in the subjoined note.

NOTE.—Dr. L. Cockayne writes upon the question of the type of *Haastia Greenii* as follows:—This plant had merely an MS. name from Hooker and the publication (which alone counts) was by Kirk....Kirk says he saw only one specimen, and I assume this was either one in his own herbarium or the Canterbury Museum plant. If the latter, as is almost certain, for he examined that herbarium, then the specimen there is the 'type.' "

THE BASIC VOLCANIC ROCKS OF BANKS PENINSULA

By R. Speight, Curator, Professor of Geology, Canterbury College.

A. Introductory:—
   1. General Features of the Area.
   2. Andesites and Basalts, criteria for differentiation.

B. Lyttelton Area:—
   1. Lyttelton Series (*a*) Andesites, (*b*) Basalts.
   2. Mount Herbert Series.
   3. Quail Island Series.

C. Akaroa Area.

D. Summary.

A.—INTRODUCTORY.

1. General Features of the Area.

The general field relations of these rocks have been dealt with in a former paper, "The Geology of Banks Peninsula" (Trans. N.Z. Inst. vol. 49, 1917, pp. 365–92). In that paper it is stated that these volcanics were extruded from three, perhaps from four, centres, consisting of (1) Lyttelton, (2) Akaroa, (3) Mount Herbert, and (4), doubtfully separated from (3), Quail Island. The two former present little difficulty. The effusive volcanic rocks consist of flows of basic lava and pyroclastic material, which are arranged with quaquaversal dip round two centres corresponding more or less exactly with the centres of the harbours, and both effusives and clastics are penetrated by a series of dykes of somewhat alkaline type ranging from very acid trachytes to typical dolerites.

The lavas of Mount Herbert consist of flows with interstratified clastic material; they contain no dykes. A recent examination of the country to the head of the Purau Valley on the south side of Lyttelton Harbour has shown me that the rock belonging to the Lyttelton volcano extends for a considerable distance on the western side of that valley, and that the veneer of Mount Herbert flows is in places quite thin, especially at the base of the steep slope which commences to rise to the summit of the mountain from about the 500 m. level. The shoulder of rocks belonging to the older system, and forming the rim of the denuded crater, on the flank of which Mount Herbert was

established, is barely covered by the more recent flows from Mount Herbert, though they are again thicker nearer the harbour level at the entrance to Purau Bay.

The Quail Island volcanics of this sequence consist of flows of basalt underlain and separated by fragmentary material.

These rocks are middle to late Tertiary in age, but it should be remembered that there was a previous volcanic episode of Cretaceous date characterised by rhyolite eruptions—flows, clastic material, and dykes of pitchstone belonging to this member of the volcanic sequence. And yet again the fragmentary material includes boulders of an andesite differing entirely from anything that appears at the surface of the Banks Peninsula. These beds, as also the intrusive rocks of the area, have been dealt with in another paper (see *antea* pp. 77–89 and pp. 121–150), and apart from general considerations will not be referred to in detail in this present paper, which will be confined principally to the basic eruptives.

Most of the specimens selected for analysis or for microscopic examination come from quarries used for road metal or for obtaining building stone, exposures on the sea shore or on the summits of hills, with occasional examples from road cuttings at various levels. In this way a tolerably accurate conspectus of the rocks existing in the area has been obtained, although the list is far from complete considering the size of the area under consideration. I regret that I have few specimens from the coastal regions extending round from Lyttelton Heads to Akaroa Heads, but it is not likely that any important type has escaped notice.

A number of specimens were selected for analysis so as to cover the chief types occurring in the area, and these were analysed by Mr. F. T. Seelye, of the Dominion Laboratory through the good offices of Mr. P. G. Morgan, Director of the Geological Survey, to both of whom my sincere thanks are due, to the former for his most excellent analyses and to the latter for his kindly influence with the Dominion Laboratory.

These analyses are, I believe, the only ones worth recording from rocks from the locality, those quoted by Haast in his "Geology of Canterbury and Westland" (pp. 350–54) being of little value, and several made by myself as a student many years ago being below the standard required in modern analyses.

The rocks from the different centres of eruption will be considered in turn, the Lyttelton area with the centres associated with it, Mount Herbert and Quail Island, being taken first.

2. Andesites and Basalts.—Criteria for Differentiation.

One difficulty as regards nomenclature will arise in connection with these rocks, viz., the precise criteria for differentiating an andesite from a basalt. Some authorities, such as Iddings, hold that the presence of olivine in fair amount associated with a felspar even as acid as andesine necessitates the rock being called a basalt. Some years ago, during Professor Iddings's visit to New Zealand, I showed him a number of my slides, and he said he would call all the rocks basalts because they contained olivine in fair amount. On the other hand, according to different authorities, a rock with a small porportion of olivine, associated with a felspar as basic as labradorite, might be called an andesite. A reference to a recent paper by Washington on the "Petrology of the Hawaiian Islands" Part 1 (Amer. Jour. Sci., vol. 5, 1923) is very relevant to this case, especially as there are certain somewhat close relationships between the rocks of Banks Peninsula and those of Hawaii, as is brought out in the paper just referred to, and also in that by Whitman Cross entitled "The Lavas of Hawaii and their relations" (U.S. Geol. Survey, Prof. Paper 88, 1915). Washington points out that the presence of olivine in a volcanic rock such as an andesite or basalt is not as a rule of such important diagnostic value that it should be used to determine entirely the class to which the rock should be assigned, but is merely an accidental feature, depending largely on the rate at which the rock has been chilled. He regards chemical composition as the best guide to classification, and uses the percentage of felspar in the norm as the basis for discrimination. He calls rocks with over 62·5 per cent. of normative felspar andesites, and those with a lower percentage basalts whether they contain olivine or not (loc. cit. p. 469).

A serious objection to this method, however, is the reliance it places on mere chemical composition, and this requires an elaborate series of analyses to be made if the naming is to be correct. There is a special difficulty in dealing with border-line cases. An interesting example of this is given by Washington on page 481 of his paper, where he calls a rock an andesite when it has a percentage of normative felspar slightly below his critical value. There is, of course, the difficulty that a rock may be called an andesine andesite when the phenocrysts are labradorite and the base oligoclase, and the rock thus contains no andesine. Such a case occurs in connection with the rock from Garland's Quarry (*postea,* pp. 241–5) where phenocrysts of labradorite are an essential feature of the rock, while the ground mass is of oligoclase, and the average felspar a basic-oligoclase. I have felt that to call the rock an olivine-oligoclase andesite would hardly convey the impression as to what it really was.

The difficulty of classification of intermediate or overlapping types from Banks Peninsula wos noted by both Kolenko and Filhol. Importance as a diagnostic character should certainly be given to mineralogical composition, and specially to the texture of the groundmass, when rocks are on the border line, and this the author has endeavoured to do as far as possible, but he has maintained a general adherence to Washington's criteria when assigning names to such rocks.

B.—THE LYTTELTON AREA.

1. The Lyttelton Series.

These rocks are arranged round Lyttelton Harbour as a central area, and consist of lava flows and beds of fragmentary material in sub-equal proportions. An estimate of the relative amount of the two classes of eruptive matter can readily be obtained by measuring the lengths occupied by each on the Lyttelton-Sumner road since that road is almost radial to the volcano. In this case the proportion appears to be about two-thirds of fragmentary material to one-third of lava flow. This proportion is similar to that disclosed in quarries and other excavations in different parts of the periphery and inside the crater ring, and also in the Lyttelton Tunnel according to the records made by Haast.

(*a*) *Andesites.*

One of the characteristic phases of the lavas of the region is illustrated by the rock from Garland's Quarry, Woolston (Anal. No. 1). This quarry is situated on the end of the spur reaching down from the edge of the caldera above Rapaki towards Opawa. It has been worked for many years, and the face is now nearly 60 m. in height. The lower half along the greater part of the face consists of solid rock, but above this lies a thick bed of agglomerate which is succeeded by another solid flow.

The rock in the hand specimen is dark in colour and speckled with felspar crystals, the proportion varying in different parts of the quarry. The sample selected for analysis being on the whole one in which felspars were rather numerous, the selection was made in order to see the effect on the analysis of a large number of felspar phenocrysts, and a consideration of the result clearly shows that the rock is of a more acid type. In fact it is much the most acid of the series. Olivine is indicated by occasional brown grains, and augites too are clearly visible. The rock in the quarry shows great variation in texture, some being

especially vesicular, and then again in the lower part of the quarry becoming compact and tough, and thus making a good road metal. In general the phenocrysts appear to occupy a larger proportion of the rock where it is most scoriaceous, allowance being made for the space taken up by the vesicles. The rock makes a fairly good building stone, and it has been used extensively in the building of the School of Engineering, Canterbury College.

ANALYSES OF LYTTELTON ANDESITES, ETC.

		1	2	3	4	5	6	7
Silica	SiO_2	56.88	49.41	50.87	50.33	47.56	50.68	50.92
Alumina	Al_2O_3	16.90	16.83	17.18	16.76	16.49	16.42	17.59
Ferric oxide ..	Fe_2O_3	3.31	3.64	4.09	4.36	2.48	5.79	3.80
Ferrous oxide ..	FeO	4.74	6.84	7.18	5.90	7.35	6.22	6.69
Magnesia	MgO	1.92	4.01	4.11	4.36	3.92	4.25	3.90
Lime	CaO	5.97	8.24	7.84	7.46	9.58	6.47	6.97
Soda	Na_2O	3.90	3.86	3.87	4.40	3.59	4.70	4.28
Potash	K_2O	2.52	1.59	1.85	2.05	1.20	2.16	1.86
Water lost above 105°C	H_2O+	0.89	0.93	0.33	0.70	0.54	0.23	0.79
Water lost below 105°C	H_2O-	0.38	1.05	0.74	0.79	0.67	0.19	0.35
Carbon di-oxide ..	CO_2	0.04	0.02	nil	nil	3.11	..	..
Titanium di-oxide ..	TiO_2	1.38	2.26	1.56	1.93	2.44	2.64	2.55
Zirconia	ZrO_2	nil	nil	nil	nil	nil	n.d.	n.d.
Phosphorus pentoxide	P_2O_5	0.67	0.88	0.48	0.58	0.64	0.17	0.40
Sulphur	S	0.03	nil	..	..	0.02	..	..
Chromium tri-oxide	Cr_2O_3	nil	0.01	..	..	0.02	..	..
Manganese oxide ..	MnO	0.12	0.15	0.17	0.19	0.14	0.22	0.20
Nickel oxide ..	NiO	0.01	0.02	0.02	0.04	0.02	..	..
Strontia	SrO	0.05	0.04	0.03	0.05	0.05	..	..
Baryta	BaO	0.07	0.05	..	0.05	0.03	n.d.	n.d.
Totals		99.78	99.83	100.32	99.95	99.85	100.14	100.30

NORMS

Q	9.90	..	..	..	2.10	..	..
or	15.01	9.45	11.12	12.23	7.23	12.79	11.12
ab	33.01	32.49	33.01	36.68	30.39	38.77	36.15
an	21.13	23.91	23.91	20.02	24.46	17.24	23.07
ne	..	..	..	0.28	..	0.57	..
c	..	..	..	..	0.31	..	..
di	3.19	9.28	9.34	10.72	..	11.28	6.99
hy	7.07	9.66	8.13	..	17.46	..	7.31
ol	..	1.28	3.73	7.28	..	5.43	3.18
mt	4.87	5.34	6.03	6.50	3.71	8.35	5.57
hm	..	..	..	..	..	..	..
il	2.74	4.41	3.04	3.65	4.56	5.02	4.86
ap	1.68	2.02	1.34	1.34	1.34	0.34	1.01
cc	..	..	..	..	7.00	..	..

No. 1. Olivine Andesite—Garland's Quarry, Opawa. 11. 4 (5). 3. 4—Tonalose.

No. 2. Olivine Andesite—Glenmore Quarry, Opawa. 11″. 5. 3. 4,—Andose.

No. 3. Olivine Andesite—Near Quarry on Road, Hoonhay Valley. 11″. 5. 3. 4.—Andose.
No. 4. Hornblende-Olivine Andesite—Andrew's Quarry, Sumner Road, Heathcote. 11. 5. 3. 4.—Andose.
No. 5. Olivine Andesite. Harbour Board Quarry, West Lyttelton, at sea level. Rock somewhat weathered.
(The above analyses by F. T. Seelye.)

No. 6. Andesine Andesite—Mauna Kea. 11. 5. (2) 3. 4. Andose. Washington. Pet. Haw. Is. Am. J.S. Vol. V., p. 491, 1923.
No. 7. Andesine Andesite—Mauna Kea. 11. 5. 3. 4.—Andose. Washington, loc. cit. p. 491 = "Trachydolerite." Daly. Jour. Geol., Vol. 19, p. 301, 1911.
Analyses Nos. 6 and 7 inserted for purpose of comparison.

The most striking feature of this rock as seen in section is the felspar occurring as phenocrysts. They occur up to 2 cm. in length, and all tests, including the analysis, show them to be a medium-labradorite. Fragments were broken from the rock and analysed (Anal. No. 1 below), and these show that it has an approximate composition of Ab_3An_4. The mineral is singularly fresh, but contains at times inclusions of magnetite, augite, of the groundmass, of apatite, and very occasional zircon, although no phosphorus pentoxide or zirconia shows in the analysis. The result corresponds somewhat closely to an analysis made by myself (*loc. cit.* p. 371) of felspars from a similar and neighbouring flow on the western side of the ridge.

ANALYSES OF FELSPAR AND AUGITE FROM LYTTELTON ANDESITES

		1	2
Silica	SiO_2	53.38	49.84
Alumina	Al_2O_3	28.85	5.47
Fenic oxide	Fe_2O_3	0.32	2.38
Ferrous oxide	FeO	0.33	4.73
Magnesia	MgO	0.16	14.16
Lime	CaO	11.68	19.27
Soda	Na_2O	4.34	0.61
Potash	K_2O	0.38	0.08
Water lost above 105°C.	H_2O+	0.28	0.58
Water lost below 105°C.	H_2O-	0.20	0.98
Carbon di-oxide	CO_2	trace	0.10
Titanium di-oxide	TiO_2	0.14	1.16
Zirconia	ZrO_2	nil	nil
Phosphorus pentoxide	P_2O_5	n.d.	0.14
Sulphur	S	nil	nil
Chronium tri-oxide	Cr_2O_3	nil	0.51
Manganese oxide	MnO	trace	0.10
Nickel oxide	NiO	nil	0.04
Strontia	SrO	0.09	nil
Baryta	BaO	trace	nil
Totals		100.15	100.15

No. 1. Felspar.—Phenocrysts from Olivine Andesite. Garland's Quarry, Opawa.
No. 2. Augite.—Phenocrysts from Olivine Andesite. Lyttelton.
(Analyses by F. T. Seelye.)

The augite of the rock occurs in greyish non-pleochroic crystals. It was not found possible to detach fragments from the matrix, but crystals of similar microscopic character were obtained from a neighbouring rock, and these were analysed, since they would certainly give some idea of the composition of the typical augites of the area. The analysis is that of an average augite such as occurs in basic rocks (Iddings, *Rock Minerals,* p. 298) the only noteworthy features being the slightly low percentage of ferric oxide, and the slightly high percentage of titanium dioxide. Some of the augites of the area must contain a much higher value than this, even. The section shows that the mineral contains inclusions of magnetite and also apatite, so the values for titanium and phosphorus pentoxide are accounted for.

The olivine is in colourless crystals, frequently altered to a greenish material, and both the olivine and augite grade down into small individuals in the groundmass. Crystals of magnetite also occur as micro-phenocrysts.

The groundmass varies considerably in texture, in some cases being holocrystalline and of coarse fabric, but this grades down in the more scoriaceous facies into one containing a reasonable amount of glass. The minerals present consist of augite microlites, much magnetite in grains, laths of oligoclase with nearly straight extinction, and a R.I. higher than that of balsam, and an untwinned felspar with lower R.I. than that of balsam, which is probably sanidine. This last-named constituent is absent from certain slides.

The analysis shows a felspar content belonging to a rock well above the dividing line assumed to distinguish andesites from basalts, also that the average felspar of the norm is a basic-oligoclase. The norm, however, differs from the actual mineral composition in certain important particulars, *e.g.*, the 9·90 per cent. of normative quartz has no counterpart in the section, and olivine does not show in the norm, although it occurs frequently in the mode. A consideration of the potash constituent of the rock and of the felspar phenocrysts shows that the microlites of the groundmass must contain a reasonable percentage of potash in addition to the moderately high amount of soda. Thus the sanidine content may be larger than an examination of the slide indicates.

The rock should therefore be called an olivine andesite, although Iddings stated definitely that he would call it a basalt on account of the olivine it contains.

Analysis No. 2 gives the composition of a representative specimen from the Glenmore Quarry, which is situated on part

of the same spur as Garland's Quarry, but is half a mile further west. The layer worked for metal caps the spur, and, as in the case of Garland's, the lower part gives the best stone. This is compact in texture, dark-grey in colour, with phenocrysts of felspar, olivine, and augite showing. The rock appears to be a segregation from a flow somewhat closely allied to that of Garland's, but a flow similar to this certainly underlies the Glenmore rock, and the specimen was selected for analysis partly to note the difference in the character of the stone from one lava stream as compared with that from another. There were other features as well which suggested the desirability of an analysis.

In section this rock shows numerous phenocrysts of a medium-labradorite frequently full of glass bubbles, also with inclusions of magnetite and augite, and with a more sodic margin; violet coloured augite up to 1 cm. in length with inclusions of magnetite specially numerous round the margin; olivine, serpentinised along cracks but otherwise clear and colourless, sometimes stained brown with iron ore, the smaller individuals being sometimes replaced by a greenish alteration product; crystals of magnetite, at times with skeletal outgrowths. The groundmass contains much magnetite, the grains also showing skeletal outgrowths; numerous grains of greenish augite; a considerable quantity of brownish-green material derived chiefly from olivine grains, but also partly from the augite; numerous very small flecks of brown mica (some of these may be hornblende, but all examined showed straight extinction); and laths and irregular shaped and quadratic prismoids of oligoclase-andesine, often with denticulate border; also occasional apatite. There are also present some untwinned microlites of felspar with R.I slightly lower than balsam which may be sanidine, the other individuals all having a higher index. Some slides show occasional amygdaloids of calcite. No glass was seen, the texture of the base being somewhat coarse for an andesite.

The analysis shows a felspar content sufficiently high for an andesite, and also that the average felspar is an acid-andesine.

Analysis No. 3 is that of a rock from the Hoonhay Valley, just alongside the road leading up to the place where the andesite of the dyke was last quarried (see *antea* p. 140). It is rough and trachytic in external appearance, vesicular, grey in colour, with numerous felspars showing, up to 1 cm. in length; there are a fair number of augite phenocrysts, and a very occasional olivine. This rock was selected for analysis since it was intermediate in age and promised from microscopical examination to be as acid as any occurring as a flow.

In section the amount of olivine shows greater than in the hand specimen, since it is an abundant phenocryst; it is at times quite fresh, and then again stained with oxide of iron. Augite occurs freely, but is quite subordinate to the olivine. The felspar phenocrysts are a basic-labradorite with more acid borders. The groundmass is composed chiefly of laths of oligoclase, sometimes showing a trachytic arrangement, the amount of augite associated with it varying; in some places the ground is almost free from augite, and then again it occurs in quantity; magnetite grains are common.

Judging by the Washington standard this rock is certainly an andesite, with an average felspar andesine, and it should therefore be called an olivine andesite.

The specimen from Andrews's Quarry (Analysis No. 4) is from one of the few occurrences of hornblende bearing rock occurring as a flow, although hornblende bearing rocks of varying grades of composition are not infrequent as dykes. The rock under consideration is found in a disused road metal quarry close to Heathcote bridge on the Christchurch-Sumner road. It was quarried for some chains along the surface of a spur stretching down towards the Estuary from the summit of Mount Pleasant, and it yielded an excellent stone, the quarry being given up when the area held was exhausted, although good stone is showing in a face right on the boundary of the holding. The flow is capped in places by loess and by scoriaceous material, but occasionally good metal was found right on the surface, little or no stripping being necessary. Red scoriaceous fragmentary material forms the subjacent layer, and judging from appearances the flow must have followed the line of a gully previously excavated in the surface of the volcano.

In the hand specimen the rock is grey in colour, with black crystals of augite and hornblende freely showing,—the latter up to 4 cm. in length; olivine grains are numerous, usually indicated by iron oxide. The number of felspar phenocrysts varies, some parts of the rock being almost free from them, and then again they become fairly numerous, up to about 1 cm. in length. The variability of the rock is confirmed by the microscopic examination, the analysis being that of a specimen with the felspars showing freely.

Under the microscope the phenocrysts exhibit the following characters. The felspar is an acid-labradorite, frequently with inclusions of grains of magnetite, apatite needles, microlites of augite, and glass bubbles, and at times with a marginal outgrowth showing a denticulate border of a felspar of more acid composition. This point should be noted in considering

the analysis. The augite is very slightly purplish in colour, at times beautifully idiomorphic, with length up to 8 mm., and frequently occurring in nests of crystals. Olivine, too, is very plentiful both as phenocrysts and as grains of smaller size in the groundmass; it is usually in colourless crystals seamed and stained with iron oxide. The hornblende is of the brown basaltic variety, partially or completely resorbed, with a border or replacement of augite and magnetite grains. Patches of magnetite grains frequently occur which can clearly be traced to original hornblende, but there are numerous other grains which have crystallised out independently.

The groundmass is composed of felspar laths with low angle of extinction, with an R.I. slightly higher than that of balsam, therefore oligoclase; augite microlites, and magnetite; a little glass is also present. The norm shows the presence of 0·69 per cent. of nepheline, but its presence was not detected.

In some of the slides felspar phenocrysts are absent and the field is crowded with augites and olivines. This occurs in sections which show resorbed hornblende and also in some which show none. This fact points to the presence of marked variations in the rock.

The chemical analysis is that of a rock which is decidedly acidic seeing that it contains so much olivine and augite. Although the felspar phenocrysts are acid-labradorite, the composition of the felspar of the norm points to the average felspar being basic-oligoclase. Further the percentage of felspar in the norm is as high as 69·21, and this necessitates the rock being called an andesite in spite of the large amount of olivine present. Iddings would certainly have called it a basalt. Its name under the Washington system would be a hornblende-olivine-andesine andesite. A comparison of the composition of the "Trachydolerite" from Mauna Kea of the Hawaii (analysis quoted for comparison No. 7) is very close, and this rock Washington calls an andesine andesite.

In only two or three other cases from among the rocks examined does hornblende appear as an important constituent mineral. One of these from the spur between Sumner and Taylor's Mistake, in one specimen of which a crystal of hornblende 2 cm. in length was found loose in a cavity. This rock is a somewhat acid basalt, similar in some respects to the one just described from Andrews's Quarry, with resorbed phenocrysts of hornblende showing under the microscope. Another instance is that of the rock in the Tramway Quarry near Redcliffs, where hornblende xenocrysts up to 5 cm. in length occur, rounded by the process of resorption. The frequence of their occurrence in

the dykes does perhaps suggest some deeper seated source from which they may have been derived.

Analysis No. 5 is of a rock occurring at the Harbour Board Quarry in West Lyttelton, just above sea-level, near the western wing of the breakwater. The rock is much decomposed, but there are hard kernels in it, and the sample selected for analysis is from one of these. It is dark grey in colour and contains numerous amygdaloids and veinlets of calcite. This facies is variable in texture. and it is singularly close-grained and hard at times. Phenocrysts of felspar, and occasional augite and olivine appear in the hand specimen.

In section the rock shows a characteristic andesitic facies. The phenocrysts are felspars, basic-labradorite, with inclusions of glass and quartz; augite slightly purplish-brown in colour with inclusions of magnetite round the margin; olivine fresh for such a weathered rock, but serpentinised along cracks, the diameter of the crystals ranging up to ·5 mm. The base consists of laths of basic-andesine, numerous small stumpy laths of augite and much magnetite which, judging from the analysis, must contain a considerable percentage of titanium. Amygdaloids of calcite and chalcedony occur freely, as well as numerous flakes of a greenish-brown hornblende and a red-brown mica, the rock resembling in this particular that from the Glenmore Quarry described previously; apatite needles also occur. Although the groundmass is at times fine grained, no glass was seen.

The more decomposed facies of the rock has a coarser base but contains the same minerals.

The rock was selected for analysis since it is one of the earliest flows of the Lyttelton area, although its somewhat decomposed condition detracts a little from the value of the analysis. This shows, however, that it is one of the group of andesites on the border line between andesites and basalts, and also that the average felspar is an andesine. The result is somewhat acid as compared with the microscopic determination of the felspar, and it is suggested by way of explanation that some quantity of the potash has been taken for the biotite in the groundmass, thus leaving the residual felspathic material more basic than that of the norm. The small amount of normative quartz is no doubt derived from the chalcedonic content of the rock.

There are other examples of similar rock occurring along the foreshore, especially near Governor's Bay, and they too are very early in the history of the volcano, since the flows lie just over the sandstone which antedates the basic volcanics, and their

occurrence in this position serves to emphasize the point that there is probably little variation in the basicity of the earlier flows from that of the average andesites of the area.

These analyses of Lyttelton rocks, taken generally, show a close resemblance to the olivine-oligoclase andesites of Washington (*loc. cit.*), but the felspar is hardly as sodic in character though approaching it. Some of his analyses (*loc. cit.* pp. 480–1) are not markedly different in normative albite from those of the rocks under consideration.

The five analyses given are typical of the andesites of the Lyttelton area, but there are cases which call for further chemical investigation. A noteworthy example is an andesite from Ahuriri, occurring on one of the points cut by the road west of the lagoon. The felspar phenocrysts are andesine-labradorite, numerous augites greyish-purple in colour and very slightly pleochroic, olivines in grains which are almost entirely replaced by iron oxide, grains of magnetite, but the groundmass is composed chiefly of felspar laths with a trachytic fabric, the felspars being as a rule with a very slightly higher R.I. than that of balsam, and a low angle of extinction and therefore oligocase, but there are others with lower index and straight extinction, and are therefore in all probability sanidine. The felspar phenocrysts, too, have outgrowths of a more sodic species. This rock is strongly reminiscent of that from the Glenmore Quarry (Analysis No. 2).

A series of specimens was taken from the Lyttelton-Sumner road to note any decided change in character as the sequence progressed, but without definite result. The earlier flows were more weathered and reminiscent of the rock at the Harbour Board Quarry, as would be expected, and contained calcite and olivines replaced by iron oxide, the later flows were fresher, and showed little variation in composition or texture. The felspars, especially those of the base, frequently showed denticulate border. In one slide tridymite was noted.

The common type of andesite such as that from Garland's or from Hoonhay grades down into compact rocks with few or no phenocrysts showing. The latter type is widely distributed, specimens being obtained from near the old Lyttelton-Sumner Road, from the cliffs alongside the Sumner tramline, from the foot of Cashmere Hills, from Landsdowne, from the Akaroa Road past Tai Tapu, and from the edge of the crater ring on the west side of the harbour. Where phenocrysts occur they are invariably small in size and of labradorite, mostly an acid variety; olivine in grains stained or replaced by iron-oxide; very occasional augite; and the groundmass is composed of laths of

felspar (oligoclase to andesine); small microlites of augite and magnetite grains, with a variable quantity of glass, the microlites frequently showing flow structure.

A number of other interesting features of this andesite should be noted. One common phenomenon is the presence of kernels of darker coloured rock within spheroids of lighter tint, the outer portions containing far more phenocrysts, as if there had been a movement of the felspars outward from the nucleus of more basic rock. The precise change in the composition of the shell, if any, cannot be determined adequately without chemical analysis. It is possible that the formation of the phenocrysts may result from the chilling of the outside of the flow or certain parts of it, while there may be little or no difference in the chemical composition of parts of the mass. As a rule, too, the lower portions of lava flows are freer from felspar phenocrysts, as if there was a gradual floating up of the crystals after they had formed as a result of gravity differentiation. The results of Anal. No. 1, from a rock specimen with many phenocrysts, does, however, point to this facies being more acidic.

Another notable feature is a red rock which occurs freely between the solid flows. Haast called it laterite, but not in the sense in which that term is applied now. Some of these red beds are ash more or less decomposed, and stained with iron oxide, but others represent the original lava, which has become oxidised probably by the action of steam immediately after the rock has been extruded, or while it is being extruded, like the red and variously coloured rocks that occur round such points as the Red Crater on the summit of Tongariro. Such red beds are markedly scoriaceous, with occasional pieces of scoria showing little colouring, and containing felspar phenocrysts only slightly decayed, and augites in perfect idiomorphic crystals with little or no sign of decomposition. These may easily be separated from the somewhat incoherent mass and at times reach a length of 2–3 cm. The groundmass is dominantly glassy. This red rock is frequently hard enough to be used for building purposes, and some of it stands uncommonly well, although from casual inspection it promises little lasting power. It has been used in some buildings for over 70 years with comparatively little sign of decay.

(*b*) *Basalts.*

True basalts form a minority of the rocks of the Lyttelton area if the Washington criteria for classification are adopted; the line of demarcation is as a rule definite, though transition

types undoubtedly occur. Macroscopical examination is at times quite delusive, since fine-grained compact rocks showing olivine and augite and a little felspar when examined in section show decided andesitic properties, and must be classified accordingly. As a rule basalts appear more common in the later flows than in the earlier. The two analyses of basalts from this area are from specimens taken on the extreme western periphery of the volcano from Halswell and the Ahuriri Lagoon.

ANALYSES OF LYTTELTON BASALTS,—MT. HERBERT AND QUAIL ISLAND ROCKS.

		1	2	3	4	5	6	7
Silica	SiO_2	48.01	44.24	48.37	47.93	45.48	47.98	47.39
Alumina	Al_2O_3	15.19	14.45	14.50	16.00	15.56	15.32	16.46
Ferric oxide ..	Fe_2O_3	3.61	2.92	5.52	4.55	4.25	2.49	3.75
Ferrous oxide ..	FeO	7.66	8.98	6.27	8.27	8.24	8.86	8.42
Magnesia	MgO	7.00	9.56	8.59	4.00	6.97	6.16	5.08
Lime	CaO	10.55	10.83	9.03	7.79	9.35	10.28	7.37
Soda	Na_2O	3.09	2.80	2.86	5.16	3.78	3.56	4.71
Potash	K_2O	1.49	1.15	1.10	1.37	1.40	1.08	1.65
Water lost above 105°C	H_2O+	0.29	0.90	0.62	0.42	0.39	0.62	0.28
Water lost below 105°C	H_2O-	0.42	0.61	1.00	0.35	0.59	0.25	0.09
Carbon di-oxide ..	CO_2	0.05	trace	nil	trace	0.10	..	..
Titanium di-oxide ..	TiO_2	2.22	2.81	1.84	2.97	2.94	3.53	2.83
Zirconia	ZrO_2	..	nil	0.02	nil	0.02	nil	nil
Phosphorus pentoxide	P_2O_5	0.44	0.70	0.33	1.00	0.83	0.22	2.22
Sulphur tri-oxide ..	SO_3	..	trace	nil	trace	nil	0.02	0.06
Chromium tri-oxide ..	Cr_2O_3	..	0.06	0.05	nil	0.03	nil	trace
Manganese oxide ..	MnO	0.14	0.16	0.13	0.20	0.15	0.12	0.09
Nickel oxide ..	NiO	0.01	0.03	0.01	0.03	trace	..	..
Strontia	SrO	0.04	0.05	0.05	0.07	0.08	..	..
Baryta	BaO	0.03	0.07	0.04	0.07	0.05	0.06	0.04
Totals		100.24	100.32	100.33	100.18	100.21	100.55	100.44

NORMS

or	8.90	7.23	6.67	8.34	8.34	6.67	10.01
ab	23.06	13.89	24.10	34.58	23.06	26.20	36.68
an	23.07	23.35	23.35	16.40	21.41	22.52	18.90
ne	1.70	5.25	..	4.83	4.83	1.99	1.42
di	21.51	20.57	15.41	12.92	15.63	21.64	3.16
hy	..	..	12.71	..	..	..	..
ol	10.68	17.13	4.18	7.60	12.07	9.79	13.70
mt	5.34	4.18	7.89	6.73	6.26	3.71	5.34
il	4.26	5.32	3.50	5.78	5.62	6.69	5.32
ap	1.01	1.68	0.67	2.35	2.02	0.67	5.04

No. 1. Basalt—Halswell Quarry, ″111.5.3.4.—Camptonose.
No. 2. Basalt—Rocky Point. Ahuriri Lagoon, 111. 5(6).3″.4.—Camptonose.
No. 3. Basalt—Diamond Harbour, Lyttelton, 111.5.3″.4.—Camptonose.

No. 4. Oligodase Andesite. Mount Herbert (summit), 11(111).5″. (2)3. 4(5).—Andose.

No. 5. Basalt—Quail Island, Lyttelton. ″111. 5″.3.4. Camptonose.
Analyses by F. T. Seclye.

No. 6. Felspar-phyric Basalt.—Kohala, Hawaii. 111.5.3.4″. Camptonose.
Washington, loc. cit. pp. 483-4.

No. 7. Olivine-oligodase andesite.—Kohala, Hawaii. 11.5″.3″.4. Andose.
Washington, loc. cit. pp. 480-1.

(Nos. 6 and 7 inserted for purpose of comparison.)

Analysis No. 1 is that of a basalt from the Halswell Quarry. The flow which has been quarried forms the crest and N.W. slope of a rise near the extremity of a spur, and is about 50 m. thick where quarried. The quarry has been in operation for over 50 years, and it still yields the greater part of the road metal used in Christchurch, and has a probable further life of from 20 to 30 years, with the same output as at present. The stone has also been used as a building stone, but is rather too dark and sombre in colour to be sought after. In the quarry there is a most remarkable development of jointing. There is first of all a series of joints parallel to the underlying fragmentary layer, *i.e.*, the cooling surface, the partings being spaced about 15 cm. away from each other, though the distance becomes less as the lower edge of the flow is approached, when they are only about 5 cm. apart. These joint surfaces are almost parallel, so that the rocks split readily into parallel-sided slabs, sometimes of great length and regularity. In other parts of the quarry a similar joint system occurs, but in some cases, especially where the flow is very thick and there is a great mass of stone placed some distance from the cooling surfaces, there is a spheroidal jointing, where the successive layers form a series of concentric spheroidal shells up to about 10 m. radius, and the dividing surfaces are crossed nearly at right angles by another sub-radial series. These joint systems render the rock extremely easy to quarry, and the parallel sides furnish a stone already partially shaped for building or paving purposes.

In the hand specimen the rock is of grey tint with small olivines and augites showing. It exhibits as a rule a well-defined flow structure, and in some places there are nests of coarsely granular material.

Under the microscope there appear a few phenocrysts of labradorite, occasional augites, and very numerous olivines slightly coloured when unaltered, but usually stained with iron oxide. The groundmass is composed of felspar laths, twinned and untwinned with low extinction angles, but all with higher R.I. than that of balsam; augite microlites, greenish in colour

and with almost straight extinction frequently in aggregations; needles of apatite; grains of magnetite; and a little glass. The analysis shows 1·70 per cent. of normative nepheline, but this mineral was not detected with certainty although small quadratic grains in the groundmass with low polarisation colours and R.I. higher than that of balsam may be that mineral.

In some parts of the quarry there are coarser grained types in which numerous phenocrysts of olivine and magnetite occur in a holocrystalline base composed of prismoids of andesine and a fair amount of granular olivine. Amygdaloidal cavities occasionally occur with calcite and arragonite, also with flat platy crystals of what is probably stilbite.

Analysis No. 2 is that of a rock from near the Ahuriri Bird Sanctuary on the S.W. side of Banks Peninsula and forming a beautifully columnar capping of a rocky point which stretches out towards the lagoon. The specimen is grey in colour, with that peculiar tint which is characteristic at times of basanites and related rocks. In the hand specimen numerous olivines and augites appear. This is the most basic of all the rocks of the area which have been analysed, and its basic character is perhaps only exceeded by some of the chrysophyric basalts of Akaroa, which were unfortunately not analysed. No phenocrysts of felspar appear in the section, but those of olivine and augite fill up the greater part of the field. The olivine is in rounded grains, iron-stained, but otherwise fresh; the augite at times shows good idiomorphic outlines, and occasionally a tinge of violet towards the margins. The groundmass is composed of brownish microlites of augite in large numbers, sometimes forming aggregates; grains of magnetite, usually squarish in section but sometimes with the skeletal outgrowths characteristic of ilmenite, so it is no doubt a titanium-rich variety; and laths of andesine-labradorite, and some glass. The entire groundmass has a R.I. higher than that of balsam. The norm of this rock shows 5·25 per cent, of nepheline, so the base was carefully scrutinised in order to see if it were present. There are minute squarish grains with very low polarisation colours which are no doubt this mineral, but they do not occur in the percentage indicated by the norm, the large amount of olivine present producing this effect. The slide also responded to staining, so a small proportion of this constituent is no doubt present, and the rock presents basanitic affinities. This occurrence emphasises the point that the later flows from the volcano were more alkaline than the earlier. This feature is to be referred to again in the case of the last flow from Mount Herbert, and also those from Quail Island.

Undoubted basalt comes from the reef just off the moles near the entrance to the basin in Lyttelton Harbour. This is exposed for a considerable area at low tide, but at high tide a small rock only is exposed, on which one of the lighting beacons is placed. In the hand specimen this rock is grey in colour, with no felspars but numerous olivines showing. There are occasional amygdaloids.

In section the slide shows much olivine in sub-idiomorphic crystals and in grains, the largest 5 mm. in length; they are at times clear, but usually seamed with iron oxides. Lare grains on magnetite also occur, brownish in colour, suggesting the presence of titanium, with skeletal outgrowths suggestive of ilmenite. I saw no augite phenocrysts. The groundmass is somewhat coarse in texture for a basalt and approaches that of a dolerite; it consists of magnetite grains which grade down in size from the phenocrysts; prismoids of labradorite usually twinned; olivine in grains; augite in prisms and grains, frequently in aggregations. The vesicles sometimes contain a mineral which has the properties of tridymite.

2. Mount Herbert Series.

All the rocks from Mount Herbert Peak and Castle Peak (also known as Mount Herbert) that were examined proved to be basalts, with one or two exceptions, which might be called andesites, the specimens selected for section making being thoroughly representative of the flows connected with that volcano. I have suggested elsewhere (Trans. N.Z. Inst., vol. 49, 1917, p. 382) that the probable centre of eruption from which these lavas came was situated in the upper part of Kaituna Valley, but this suggestion is prompted rather by the form of the valley, and the absence of any other likely centre, rather than by any definite evidence. I have not examined critically the lavas on the eastern side of the valley to see if flows from Mount Herbert overlie those from Akaroa or Lyttelton, or whether they are absent. Further field and microscopical work are necessary before either proposition can be established.

One of the two lavas selected for analysis comes from the quarry near Diamond Harbour at sea-level, whence ballast was originally obtained, and the other is from the summit rocks just south of the Trig. station (alt. 917 m.). In the hand specimen both rocks are grey in colour, with well defined flow structure, compact, and showing small phenocrysts of olivine and augite.

The slide of the former shows phenocrysts of olivine, occasionally idiomorphic but usually in grains which grade down

to small sizes found in the groundmass; they are at times clear but usually stained on the margins and seamed with iron ores. Grey augites also occur sparingly. The base consists of felspar laths all with higher R.I. than that of balsam and with the extinction angle of a basic-andesine, and frequently with the denticulate margin of a more sodic felspar, exhibiting at times well marked flow arrangement; grains of olivine; microlites of greyish augite, round or with stumpy lath form; grains of magnetite. No glass appeared in the slides I examined, but there were occasional grains of low polarisation colour which might be nepheline. However, the norm shows no nepheline, so its presence cannot be considered demonstrated. The norm shows that the average felspar is andesine, which agrees with the microscopic determination; this is a somewhat acidic value for the felspar of such a basic rock as is disclosed by the analysis. (No. 3, p. 252.)

This rock may be taken as typical of the occurrences near Diamond Harbour, since similar sections were obtained from specimens from other parts of the ballast quarry, from the quarry near the point, and from the spoil heap of the trial bore sunk to obtain a water-supply about 1000 m. up the spur from Godley House.

The western bastion of the Mount Herbert mass forms what is known locally as Castle Peak, although it appears on the official maps as Mount Herbert,—the latter being a most confusing name, and therefore I have used the former for preference. The lavas here consist of massive horizontal flows overlying unconformably the older lavas and pyroclastic material of the Lyttelton volcano. They have a mesa-like landscape form with steep, frequently precipitous, rock faces, where the columnar structure of the flows is clearly shown, the columns being at times 6 m. in length and 75 cm. in diameter.

The rocks are basaltic in character, and show a close relationship in mineral composition but a variation in texture; some are almost coarse enough to be called dolerites, while others are fine-grained. The phenocrysts consist of medium to basic-labradorite; augite at times in large crystals up to 2 cm. in length; olivine in idiomorphic crystals or with irregular form and grading down into small grains in the base; magnetite in well-formed crystals. The groundmass consists of felspar laths (labradorite to andesine); augite grains greyish to greenish in colour, and much magnetite in grains. There are also numerous patches of isotropic material, which is no doubt glass showing throughout the slides, even in those which are coarse grained. In some cases there is a gradual passage downwards of the

phenocrysts of felspar through micro-phenocrysts into the prismoids of the base. The smaller felspar laths frequently exhibit flow structure.

The next analysis, No. 4, is perhaps the most interesting of the whole series. It is of a rock forming the actual summit of Mt. Herbert Peak from an outcrop a little distance south of the trig. pole, and it is thus in all probability the latest flow from the volcano. The rock is compact in texture, grey in colour, with flow structure well developed. In section no phenocrysts of felspar appear, and there are a few micro-phenocrysts of augite and olivine, the latter in greater number, and usually clear and unaltered; there are also large grains of magnetite.

The groundmass contains numerous microlites of an acid-andesine with flow arrangement, twinned and untwinned, with higher R.I. than that of balsam; there are also colourless untwinned grains with lower index than balsam, which are perhaps sanidine. The augite microlites of the base are greenish in tint, sometimes forming aggregations; magnetite in grains is also especially numerous. There are also a fair number of squarish grains with low polarisation colours and index of refraction less than that of the felspar, which were taken to be nepheline. The conclusion was confirmed by staining, when the grains could be definitely picked out. There is thus a definite case of the occurrence of a felspathoid in the extrusive rocks of the area.

The analysis of the rock presents several important features. The felspar content of the norm shows the rock to be an andesite, with an average felspar of oligoclase composition; the percentage of alkalies, 6·53, is the highest of the basic rocks analysed, and of this 5·16 per cent. is soda. There is also 4·83 per cent. of normative nepheline. This amount is exceeded in only one instance in the list of analysis given, but the amount of nepheline actually present in the slide probably exceeds the others, those cases where less occurs being probably due to the formation of a large amount of olivine, *e.g.*, the Ahuriri and Quail Island basalts.

The general texture of the rock is trachytic in character, especially as regards the flow arrangements of the laths, and following the accepted scheme of classification should be called an oligoclase andesite. It corresponds fairly closely to the rock from Kohala, Hawaii (*loc. cit.* p. 480–1), of which an analysis is quoted for comparison (No. 7); this rock is slightly more felspathic, but the composition of the average felspar is a trifle more basic.

3. Quail Island Series.

All the rocks examined proved to be basalts. The analysis No. 5 is of a rock which occurs as boulders on the S.E. side of the island at sea level, and which must have been shed from the lava flows immediately above it, now covered with loess, soil, etc. As seen in the mass the rock is greyish in colour, but with crystals of olivine standing out on the weathered surface—an indication that the groundmass contains a more rapidly weathering substance than even olivine. The analysis shows 4·83 per cent. of normative nepheline, which agrees with this conclusion.

In section the phenocrysts are olivine, which occurs freely both in idiomorphic crystals and as grains; occasional augites, and grains of magnetite. The groundmass is somewhat variable in composition; some parts show a free development of felspar laths (andesine) frequently with flow arrangement; augite microlites; grains and dust of magnetite; and an occasional clear colourless mineral with very low polarisation colours and R.I. close to that of balsam,—there is a response to staining as well,—so that this mineral is almost certainly nepheline. Glass in patches also appears in the slide, indicated by its isotropic character and a R.I. too high to be one of the other felspathoids such as analcite, etc. In some parts of the slide there is an holocrystalline aggregate of augite, magnetite, and quadratic grains of nepheline with few felspar laths. This rock, therefore, shows basanite affinities.

Rocks of similar character occur in other parts of the island, for example, on the shore immediately north of the outer wharf, and also along the north side, the basement rocks being rhyolites, and the basalts forming a mere veneer along the north and west. In the sample from near the wharf, the presence of the mineral with the low polarisation colours is very noticeable, but there are also patches which have no effect on light and which are no doubt glass. In some slides there are very occasional phenocrysts of felspar, untwinned but with more acid border, all with a higher R.I. than that of balsam. In a specimen from the north side of the island the groundmass contains many laths of andesine, twinned and untwinned, with grains and stumpy crystals of augite in clusters in among the mesh of felspar, and many grains of magnetite; the phenocrysts are of olivine in large number, associated with occasional augite. These rocks, therefore, show a close relationship to typical basanites.

Two somewhat coarse types were also obtained, one from the beach on the north side and the other from the shore of the

bay on the extreme north-west of the island. The former is a dolerite with sub-ophitic structure, containing much olivine, faint purplish-grey augite, ilmenite in broken-comb forms, labradorite prismoids, some apatite, and a considerable amount of brown coloured material filling cavities with agate-like banding (? chalcedony), and stained with decomposition products from the olivine. The latter rock presents some peculiarities. The augite is purplish in colour with the tint strongly marked towards the edges and there is much of it; olivines are numerous, both idiomorphic and in grains, stained brown with iron oxide. There is much magnetite; labradorite in stout laths; areas with low polarisation colour; and glass in patches frequently clear but sometimes stained brown; apatite occurs in needles. In addition to these there are inclusions of a greenish augite associated with felspar, the former entirely different in character from the purplish titan-augite and the latter untwinned but with higher R.I. than that of balsam. Several of these patches were noted in the slides; and in one case greenish augite laths projected into crystal of quartz and outside this was a border of granular augite. These inclusions have no doubt been derived from an alkaline plutonic rock existing below.

C.—THE AKAROA AREA.

The rocks of the Akaroa area show a general resemblance to those of Lyttelton except that they are on the whole more basic. Specimens were collected from a representative series of localities, the following being paid special attention:—The beach at Akaroa past the boatsheds, Wainui and Wainui Island, Onawe, Lushington Bay, the crest of the caldera above Akaroa, and likewise the crest from Mount Bossu to the Hilltop, Mount Sinclair, and View Hill. Occasional specimens were obtained from the road-cuttings on the slopes of the hills. Analyses were made of three specimens, the first two of rocks of andesitic facies, and the last of a basalt of acid type.

Analysis No. 1 is that of a rock from Stony Bay Road at about 500 m. above the town of Akaroa, on the inside slope of the crater. In the hand specimen the rock is compact, dark grey in colour, with numerous felspars and occasional augites and felspars showing; its appearance is strongly suggestive of Lyttelton specimens. In section the felspar phenocrysts are labradorite up to 1 cm. in length, occasionally showing outgrowths of more acid felspar; augites rare and greyish-purple in tint with a border zone containing numerous grains of magnetite; the olivine sometimes fresh but usually altered to ser-

pentinous aggregates with greenish colour; magnetite with some titanium content, frequent in large grains, brownish in colour and frequently with skeletal border; apatite is also present. The groundmass is composed of material all of which has a R.I. higher than that of balsam; it contains much magnetite in grains, augite microlites, and laths of acid-andesine; no glass was detected.

ANALYSES OF AKAROA LAVAS.

Silica	SiO_2	46.14	45.98	45.51
Alumina	Al_2O_3	17.03	16.74	15.51
Ferric oxide	Fe_2O_3	4.18	4.46	4.55
Ferrous oxide	FeO	7.68	7.75	8.51
Magnesia	MgO	4.94	4.96	4.98
Lime	CaO	8.84	9.20	8.28
Soda	Na_2O	3.43	3.51	3.42
Potash	K_2O	1.44	1.26	1.48
Water lost above 105°C. ..	H_2O+	1.27	1.24	1.47
Water lost below 105°C. ..	H_2O-	0.98	0.66	0.92
Carbon di-oxide	CO_2	0.10	0.12	0.58
Titanium di-oxide	TiO_2	3.04	3.17	3.68
Zirconia	ZrO_2	nil	nil	nil
Phosphorus pentoxide ..	P_2O_5	0.77	0.69	0.80
Sulphur	S	..	trace	nil
Chromium tri-oxide ..	Cr_2O_3	..	trace	nil
Manganese oxide	MnO	0.16	0.16	0.25
Nickel oxide	NiO	0.01	0.02	0.02
Strontia	SrO	0.05	0.07	0.04
Baryta	BaO	0.05	0.08	0.04
Totals		100.11	100.07	100.04

NORMS.

	1	2	3
or	8.34	7.78	8.90
ab	28.82	29.34	28.82
an	26.97	26.13	22.52
ne	..	..	..
di	9.21	11.22	7.63
hy	1.96	..	7.41
ol	8.80	9.05	5.51
mt	6.03	6.50	6.73
il	5.78	6.08	6.99
ap	2.02	1.68	2.02
cc	..	0.30	1.30

No. 1. Olivine Andesite.—Stony Bay Road, Akaroa. 11(111).5.3″.4.—Andose.

No. 2. Olivine Andesite.—Quarry, Barry's Bay-Little River Road, height about 200 m. 11(111).5.3″.4.—Andose.

No. 3. Basalt.—Duvauchelles Bay Road, near wharf, at sea-level. 11(111).5.3.4.—Camptonose.

All analyses by F. T. Seelye, Dominion Laboratory.

A consideration of the analysis shows 64·1 per cent. of normative felspar, so the rock must be considered an andesite, and the average felspar has the composition of andesine. The high content of iron ore disclosed by the microscopic examination is borne out by the analysis, in which the percentage of normative magnetite and ilmenite totals 11·81 per cent., titanium oxide being a notable constituent. The rock is thus an olivine andesite.

Analysis No. 2 is of a rock from the Little River—Barry's Bay Road on the inside of the caldera from a height of about 200 m. In the hand specimen the rock is darker in colour than No. 1 and the felspar phenocrysts, though present, are not so prominent. In section the phenocrysts consist of an acid-labradorite felspar, magnetite, some augite and olivine. The rock is fresh in appearance as are also the grains of olivine in the groundmass, but there are numerous vesicles filled with alteration products stained with oxides of iron, which have perhaps been derived from altered olivine. The groundmass consists of andesine laths, with augite grains and microlites, much magnetite in granules, and a little glass.

The analysis of this rock gives a norm with an average felspar of the composition of a medium-andesite, and further the total percentage of felspar amounts to 63·25, which is very little above Washington's critical value.

Analysis No. 3 is of a rock occurring at sea-level on the Duvauchelles Bay Road just north of the wharf. It is a dark compact rock in the hand specimen with a few phenocrysts of felspar showing. Under the microscope these prove to be an acid-labradorite, some with a denticulate border of more acid variety, but all with a R.I. higher than that of balsam and also of the felspars of the groundmass. In the base olivine occurs in grains; and also much titaniferous magnetite; augite; and prismoids of felspar, mostly twinned but some untwinned with nearly straight extinction, but all with higher index than balsam, being thus an oligoclase-andesine. Some glass occurs, as also cavities filled with carbonate amygdaloids of small size. The whole impression of the rock as a result of the micro-examination hows it to be somewhat acid. This is borne out by the analysis. Although the percentage of normative felspar is 60·22, which is below Washington's critical value, and would necessitate the rock being called a basalt, yet its relations to the andesites are very close, and a comparison with analysis No. 1 shows that it contains an average felspar of more acid character, although the total percentage of the average felspar is less. This

average felspar is of the composition of an acid-andecine. The high percentage of titanium di-oxide is noteworthy; the percentage of magnetite and ilmenite in the norm totals 13·72 per cent., and this high value has the effect of diminishing the percentage of felspars relative to the rock as a whole, and thus brings down its value below the Washington line, although the rock is really andesitic in its relations.

It is unfortunate that no other analyses could be obtained, since one or two of decided basic type would be advantageous. This is especially the case with a rock on the foreshore near the Monument, Akaroa, which shows prominently large blebs of olivine, 2 cm. in length, and augite as well, but very little felspar. Under the microscope fully one-third of the area of the slide was taken up with fresh, unaltered olivine and augite, only an occasional phenocryst of labradorite being present. The groundmass was composed of andesine laths, augite, and much magnetite probably titaniferous. This is perhaps the most basic of the rocks encountered in the Akaroa area.

From the examinations made the variation in the character of the rocks appears to be more a matter of texture than of mineral or chemical composition, and many would lie on the border line between the basalts and andesites as determined by Washington. The felspar phenocrysts are invariably labradorite, —none with a lower index of refraction than balsam was met with. They frequently show a more acidic border and contain inclusions of the groundmass in the border among which are microlites of augite and magnetite. In one case at least in a rock from Mount Sinclair there was a central core of felspar with a lower index than the outer zone, a phenomenon which I could not account for under the circumstances, since the main mass of the crystal was certainly labradorite and the felspar of the groundmass andesine. The denticulate margins of such felspar phenocrysts are repeated in the laths of the groundmass, but no border was detected more acid than oligoclase, since in every case tried the R.I. was higher than that of balsam.

The augites occasionally exhibit a slight violet tinge, notably those in which titanium-bearing magnetite is a prominent associated constituent. Olivine, an almost universal constituent,, may be clear, almost colourless, and unaltered, or seamed and stained with iron oxide, at times completely replaced (? iddingsite), and in some of the older flows it has been serpentinised.

In a coarse grained doleritic type from View Hill, Little Akaloa, there occurs, in addition to the ordinary minerals, brown hornblende and a little biotite. The augite of this rock is dis-

tinctly greenish in tint; there is also a considerable amount of apatite.

Occasionally carbonate products of alteration occur, and very rarely chalcedony. No felspathoid was detected for certain. The marked importance of olivine as a phenocryst, as explained previously, militates against the possibility of the occurrence of nepheline or leucite. If such does occur it must be in small amount, but it is probably absent.

Although in many cases fine grained types of normal basalt are frequent, in some cases fine grained rocks occur which in the hand specimen suggest basalt, but under the microscope prove to be composed of andesine laths, augite microlites, grains of magnetite, and some glass, and are therefore andesites. In these at times there are a few phenocrysts of olivine.

In determining to what group a rock should be assigned, a certain standard border-line type was kept in view, the rocks analysed being used for this purpose, and if the rock showed a more basic character it was called a basalt, and if a more acid character, an andesite, although olivine might be present. This course was adopted if analyses were not available.

There seemed to be no definite succession of types from basic to andesitic or *vice versâ,* as the series was considered in stratigraphical sequence. Basalts appear as commonly in the earlier flows as in the later, but on the whole they are of relatively less importance than the andesites.

D.—SUMMARY OF RESULTS.

A summary of the foregoing results shows that the lavas of the area are chiefly olivine-augite andesites, with a subordinate development of true basalts. The felspars are somewhat acid for such basic rocks, especially those of the second generation, which frequently show denticulate outgrowths of more acid felspar, a characteristic also displayed in less marked degree by the phenocrysts. Olivine is an almost universal constituent even in the andesites, and there is a marked absence of hypersthene, as might be expected, since the two minerals do not occur as a rule in association in volcanic rocks; and its absence is noteworthy since hypersthene is such an important constituent of andesites in many parts of New Zealand. The importance of olivine in the rocks of Banks Peninsula is also shown by its presence in the intrusive trachytes, trachy-andesites, and andesites. The variety of olivine which occurs is decidedly ferriferous, judging from the nature of the alteration products. The augite present is of the usual type, but at times it is distinctly

titaniferous. Hornblende is rare, usually in the resorbed condition, and mica is very rare indeed. Magnetite is a very important constituent, forming at times over 10 per cent. of the rock, and it is often markedly titanium-bearing. The presence of a large amount of magnetite appears to be a frequent feature of Pacific Island rocks. Only very seldom does nepheline appear for certain; in some cases, though a constituent of the norm, its presence is extremely doubtful or the amount very small indeed. In all probability the large amount of olivine is somewhat hostile to its appearance since the silica used for this mineral would be less than is necessary for the formation of a metasilicate, and thus an unused amount would be available for the formation of a felspar, especially one of the sodic type, whereas had augite or hypersthene formed initially and used this up some nepheline would undoubtedly have crystallised out. This action is rendered all the more probable since olivine is such a prominent phenocryst, and has crystallised out very early (Bowen-Andersen effect).

These appear to be the chief mineralogical features of the rocks, but the investigation can only be regarded as preliminary, and more detailed work on particular localities may necessitate these conclusions being modified. Although specimens of some 110 rocks have been examined, no part of the area has been completely dealt with. But with the information already to hand, in addition to that on the rhyolite and intrusive rocks in my former papers (*antea* pp. 77–89, and pp. 121–150) a summary of the general results may not be out of place.

In carrying on the investigation of the dykes, sections were made from over a hundred rocks, 74 belonging to the Lyttelton system, and 30 to the Akaroa system. Of the former 54 are trachytes or trachytoid phonolites, 4 are trachy-andesites, and 16 are basalts or dolerites, while of the latter system 23 are trachytes and 7 basic in composition. Since no discrimination had been made in the selection of dykes for examination, and basic dykes, being more uncommon, were examined wherever found, these numbers give an approximate relative proportion of the dykes present and a rough idea of the relative volume of the intruded matter. All the same the estimate somewhat disparages the importance of the trachytes since in the neighbourhood of Quail Island and of Onawe their occurrence is so common that specimens were not taken from all, but only from those that presented some possible peculiarity from examination of the hand specimen. Further, the size of the trachyte dykes is on the average much greater than that of the basalts and related rocks, so that it will be seen that the

trachytes are in overwhelming importance, and this is all the more remarkable since I have not seen or examined a single specimen from a flow that is undoubtedly trachytic.

The succession of lavas magmas in the areas appears to be as follows:—

1. Andesites, of Pre-Cretaceous age, a conclusion based on fragments of andesite in the clastics of No. 2.
2. Rhyolites,—of Cretaceous age.
3. Olivine andesites and basalts,—some of the latter slightly alkaline. Mid-Tertiary in age.
4. Dykes of trachyte and trachy-andesites with a few basalts and dolerites,—probably contemporary or slightly later than 3.
5. Basalt flows, some of them alkaline in character, no dykes occurring at Mount Herbert and Quail Island,—Late Tertiary, or perhaps even Early Pleistocene in age,—an age deduced chiefly from the stratigraphical position, and also from the recency of the stream development on the slopes leading down from Mount Herbert to Diamond Harbour. This conclusion is confirmed by a more detailed examination of the fossils recently discovered at Charteris Bay.

A definite place is not assigned to the Onawe plutonics, as their date is uncertain; they are, however, earlier than No. 4.

The origin of the trachytes and the reason for their extrusion at the particular stage in the volcanic history of the area are problems awaiting solution. They may arise from the differentiation of a somewhat alkaline—predominantly sodic, magma, but this is a mere supposition. In such a case the absence of complementary dykes would be difficult to explain, unless the basic and slightly alkaline later flows, of periods 3 and 5, which were extruded subsequently to the intrusion of the dykes, represent the more melanocratic differentiate. There is besides no evidence of the presence of calcareous rocks in masses underneath the volcano, by the assimilation of which alkaline rocks might be produced in accordance with the Daly hypothesis of their genesis, although calcite does occur in the gabbro and also very sparingly in the underlying greywackes at Gebbies' Pass.

It is a noteworthy fact that trachytes, and frequently sodic trachytes, do occur quite commonly in widely separated places, both as dykes and as flows, associated with basic lavas. Leaving out of consideration the occurrence of phonolites whose relations

are somewhat similar, illustrations of this association are to be found in such localities as the following:—Isle of Skye[1], the Mount Macedon District of Victoria[2], the South-eastern part of Queensland[3], the Hawaiian Islands[4], the Marquesas[5], Samoa[6], and other Pacific Islands[7], Reunion Island[8]. But the areas that correspond most closely with Banks Peninsula are the Hawaiian Islands and that described by Richards in South-eastern Queensland, the latter not only from the similarity of the magmas but also from its position on the boundary of the areas of alkaline and sub-alkaline rocks, and of the types of coastline, viz., the Atlantic and the Pacific, which fringe the Pacific Ocean.

The line of junction of the two types according to Harker crosses the Tasman Sea from the south-eastern part of Queensland to the South Island of New Zealand, and falls between the rich alkaline province of Dunedin on the one hand and the andesitic province of the middle of the South Island, and of its more striking development in the North Island on the other. There is no positive evidence, however, of the presence near Banks Peninsula of either faulting or folding with which rocks of the two types are supposed by Harker to be associated.

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Apart from the rhyolites, which closely resemble those of the Malvern Hills-Rakaia Gorge-Mount Somers-Rangitata belt, the rocks of Banks Peninsula show little in common with the other volcanics of Canterbury. The andesites which are associated with these rhyolites, probably overlying them, are of the hypersthene-bearing variety with no olivine, whereas the dolerites and basalts which occur in the eastern foothills of the Southern Alps are generally characterised by basic felspars, and differ in texture from those of Banks Peninsula. The occasional occurrence of a teschenitic type with analcite and nepheline as intrusives at Rakaia Gorge, High Peak, and in one or two other places, is the only suggestion of a relationship to the slightly alkaline but distinctly soda-bearing peninsula rocks, a relationship which is more definite in the case of the dykes of the system, but even this resemblance is not a close one. On the other hand the connection with the rocks of various Pacific Islands is reasonably intimate.

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(UNIVERSITY OF NEW ZEALAND)

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Prof. R. SPEIGHT, M.A., M.Sc., F.G.S., F.Am.G.S.
Curator

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LEPIDOPTERA OF THE CHATHAM ISLANDS

By E. Meyrick, B.A., F.R.S.

In the Transactions of the Entomological Society of London for 1902, pp. 273-9, I published an account of a collection of Lepidoptera made in the Chatham Islands by Mr. J. Fougère. Through Mr. A. Tonnoir, of the Canterbury Museum, a further collection of about 260 specimens, made by Messrs. G. Archey and C. Lindsay, have now been submitted to me for examination ; with the results of this study I have here incorporated those of my former paper, which, together, comprise, I believe, all known records. These are summarised as follows :—

After correction of previous errors forty-three species in all are recorded, which may be grouped in the following classes :—

(*a*) Three domestic species, which are undoubtedly introduced by direct agency of man.

(*b*) One cosmopolitan species (*Agrotis ypsilon*) of strong flight and hardy constitution, which probably finds its own way everywhere.

(*c*) Six species generally common both in New Zealand and Australia, but probably all Australian in origin ; these all evidently possess special facilities for distribution, but it is uncertain what they are ; perhaps they take advantage of human agency in some way.

(*d*) Twenty-four indigenous New Zealand species, mostly of common occurrence. It seems highly improbable that so many species could strike these little islands if blown out to sea under present conditions, and it can be definitely stated that most of them, at any rate, are most unlikely to have been introduced by man ; I therefore infer that in the main they form part of a common fauna, dating back to a period when there were much more extensive (but not necessarily continuous) land-surfaces in these waters, and mutual intercommunication was much easier than at present ; such times must have been geologically quite recent.

(*e*) Nine species, which are endemic, so far as is known. Of these seven belong to the most familiar New Zealand genera, in which they constitute additional species of ordinary type, which would have excited no surprise if discovered in New Zealand ; I presume them to form part of the common fauna mentioned above. The other two are more interesting and unexpected. *Hectacma decoranda* is a very distinct species of a genus which ranges from

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We have to express our indebtedness to Mr. G. V. Hudson, of Wellington, for kindly arranging this collection prior to its despatch to Mr. Meyrick.—R.S.

India and Ceylon to New Zealand, but does not approach the known New Zealand species ; I should regard it as of a Polynesian type, *Monopis typhlopa* is a peculiar species of a cosmopolitan genus ; the members of it are usually semi-domesticated or parasitic on human settlements, and their specific development can hardly antedate these, but may be considered a sort of index to them ; I think it is quite likely that *M. typhlopa* may be strictly confined to the Chatham Islands, in which case it affords important evidence of the early visitors who introduced it.

HYPSIDAE.

1. **Nyctemera annulata** Boisd. Mangere I., 1 ex. (Lindsay), Common in New Zealand, also in Kermadec Islands.

CARADRINIDAE.

2. **Agrotis ypsilon** Rott. Mangere I., 1 ex. (Lindsay). Cosmopolitan.

3. **Persectania composita** Guen. Mangere I. (Fougère, Lindsay). Common in New Zealand and Australia.

4. **Persectania propria** Walk. (Fougère). New Zealand (South Island).

5. **Melanchra bromias** Meyr. Owenga, Whangamarino, Mangere I. (Fougère, Lindsay). Endemic ; allied to the New Zealand species *mutans* and *insignis*, but quite distinct. Of this species Lindsay writes, " attracted by a candle in the tent, but not more than three specimens were taken on any one night, and these usually at a late hour." It varies in colouring like its two allies.

6. **Ariathisa comma** Walk. Maunganui, 1 ex. (Lindsay). Common in New Zealand.

HYDRIOMENIDAE.

7. **Phrissogonus denotatus** Walk. Maunganui, 9 ex. (Lindsay). very common in a piece of bush at the back of the homestead, here only. Common in New Zealand and Australia, also in Kermadec Islands. One example has a white subdorsal blotch in median band.

8. **Chloroclystis semialbata** Walk. Maunganui, 2 ex. (Lindsay) Common in New Zealand, also in Kermadecs and Auckland Islands.

9. **Hydriomena similata** Walk. Maunganui, Kaingaroa, 3 ex. (Lindsay). Common in New Zealand.

10. **Hydriomena haemophaea**, n. sp.

♂ 34 mm. Head, palpi, thorax light reddish-ochreous. Forewings with termen hardly bowed, little oblique, slightly waved ; reddish-ochreous ; a basal patch of grey curved transverse striation, edge obtusely angulated in middle, edged by an ochreous-whitish

stria ; space between this and median band suffused light greyish ; median band suffused grey, with darker grey striae, broad on costa, and becoming narrower downwards, edged by reddish-ochreous striae, anterior with acute angulations outwards above and below middle and inwards in middle, posterior partly marked white, rather irregularly waved, with short broad obtuse double prominence in middle ; discal mark small, blackish, transverse ; a subterminal fascia of grey suffusion connected with termen by suffused dark grey bars ; an irregular white costal spot just before apex, tinged reddish on costa (cilia imperfect). Hind wings ochreous grey-whitish, towards termen slightly reddish-tinged ; a dark grey discal dot ; a subterminal series of faint cloudy greyish spots ; cilia reddish-whitish.

Whangamarino, 1 ex. (Lindsay). Very distinct ; nearest the New Zealand *hemizona*.

11. **Hydriomena deltoidata** Walk. Wharekauri, Waiparua, 6 ex. (Lindsay). Common in New Zealand.

12. **Hydriomena subochraria** Doubl. Kaingaroa, Owenga, Maunganui, the Ngaio, 9 ex. (Lindsay). Common in New Zealand and Australia.

(*Xanthorhoe rosearia* Doubl. This was recorded formerly with some doubt on the strength of a single specimen ; I have re-examined this specimen, which is in my collection, and am now satisfied that it is a rather worn example of *homalocyma ;* the species must, therefore, be expunged from the Chatham Islands list).

13. **Xanthorhoe venipunctata** Walk. Recorded erroneously as *lucidata* (Fougère). Common in New Zealand.

14. **Xanthorhoe homalocyma** Meyr. Wharekauri, Kaingaroa, Waiparua, the Ngaio, Maunganui, Mangere I. Endemic ; nearly allied to the New Zealand *rosearia, semifissata,* and *subductata,* but distinct from all, though variable. It seems to be generally common (Fougère, Lindsay).

15. **Xanthorhoe chlorocapna,** sp. n.

♂ 24-26 mm. Head, palpi, thorax pale greyish-ochreous irrorated blackish. Antennal pectinations ten ; forewings with termen slightly bowed, rather oblique ; light smoky-grey suffusedly irrorated dark fuscous ; costal area from base to ⅘ rather broadly suffused pale greyish-ochreous, with groups of two antemedian, and three postmedian dark fuscous shades crossing it, but becoming obsolete downwards ; discal spot small, transverse, dark fuscous ; cilia whitish, basal half dark grey. Hind wings dark grey ; cilia whitish, basal third grey.

Mangere I., 6 ex. (Lindsay). Very distinct ; the nearest New Zealand species is, perhaps, *periphaea*.

STERRHIDAE.

16. **Leptomeris rubraria** Doubl. Mangere I., 1 ex. (Lindsay). A very common Australian insect, which has established itself also in New Zealand and the Kermadecs.

MONOCTENIADAE.

17. **Adeixis griseata** Huds. "Only observed on swampy ground round the edge of Lake Rotokawau, near Wharekauri; on walking through the swamp it was driven out of rushes, moss, etc., in moderate numbers, in company with a *Crambus*" (Lindsay). These examples are identical in character with the New Zealand insect, which is a modified representative of the common Australian *inostentata*.

SELIDOSEMIDAE.

18. **Selidosema ombrodes** Meyr. Mangere I., Kaingaroa, Wharekauri, Maunganui (Fourgère, Lindsay). Endemic; "very common in the bush at Wharekauri, fully 75 per cent. of the specimens too old and weather-worn to be of service" (Lindsay), but fifty examples were taken.

19. **Sestra flexata** Walk. Wharekauri; 2 ex. (Lindsay). Common in New Zealand.

NYMPHALIDAE.

20. **Vanessa gonerilla** Fab. Owenga, Maunganui, Mangere I.; 7 ex. (Lindsay). "Usually to be met with in sheltered situations in all parts of the Chatham group visited; it was much more wary than the New Zealand insect, and was very difficult to catch, being very easily alarmed when settled, and a rapid flyer on the wing" (Lindsay). Common in New Zealand.

CRAMBIDAE.

21. **Crambus ramosellus** Doubl. Only one much damaged specimen has been taken (Fougère). Common in New Zealand.

22. **Crambus siriellus** Meyr. Wharekauri, Maunganui, Mangere I.; 7 ex. (Lindsay). A local New Zealand species.

23. **Crambus vittellus** Doubl. Wharekauri, Mangere I.; 2 ex. (Lindsay). These examples are both of the form in which the white stripe of forewings is interrupted by the dark angulated lines. Common in New Zealand.

24. **Crambus horistes** Meyr. Wharekauri, Mangere I., Maunganui, the Ngaio (Fougère, Lindsay). Endemic; this distinct species is evidently the common *Crambus* of the group, as Mr. Lindsay brought 38 examples.

PYRAUSTIDAE.

25. **Nymphula nitens** Butl. Mangere I., 1 ex. (Lindsay). An Australian insect, also established in New Zealand.

26. **Musotima nitidalis** Walk. Wharekauri; 1 ex. (Lindsay). Common in Australia and New Zealand; this example resembles the New Zealand form in being darker-coloured than the Australian form, which is yellower.

27. **Mecyna pantheropa** Meyr. Wharekauri, Mangere I. (Fougère, Lindsay). Endemic; Mr. Lindsay only took three examples of this.

28. **Mecyna marmarina** Meyr. Maunganui, Kaingaroa, the Ngaio, Mangere I. (Fougère, Lindsay), common. Common also in New Zealand.

29. **Scoparia philerga** Meyr. Mangere I., Owenga; 7 ex. (Lindsay). Common in New Zealand.

30. **Scoparia minusculalis** Walk. Mangere I., Wharekauri, Maunganui; 9 ex. (Lindsay). The white markings of the forewings are more variable in extent than in my series of New Zealand specimens (in which they are nearly uniform), sometimes partially and variably obsolete. Common in the South Island of New Zealand.

31. **Scoparia indistinctalis** Walk. Mangere I., Kaingaroa; 3 ex. (Lindsay). Rather common in New Zealand.

32. **Scoparia leptalea** Meyr. Mangere I., Owenga; 8 ex. (Lindsay). Common in New Zealand. I now consider that *leptophaea* Meyr., of which the original examples were all in poor condition, cannot be properly maintained as distinct from this, and must be treated as a synonym.

33. **Scoparia sabulosella** Walk. Maunganui, Wharekauri; 3 ex. (Lindsay). Common in New Zealand.

PTEROPHORIDAE.

34. **Platyptilia aeolodes** Meyr. This species (not met with by Mr. Lindsay) was originally described from six examples taken in the Chatham group by Mr. Fougère, but was subsequently found also in New Zealand and Auckland Islands.

TORTRICIDAE.

35. **Tortrix excessana** Walk. Maunganui (Fougère, Lindsay). Common in New Zealand, whence it may easily have been introduced artificially with garden plants.

EUCOSMIDAE.

36. **Bactra xystrota** Meyr. Owenga; 2 ex. (Lindsay). Also in South Island of New Zealand, apparently local.

OECOPHORIDAE.

37. **Borkhausenia pseudospretella** Stainte. Taken by Mr. Fougère ; an introduced domestic species of wide range.

LYONETIADAE.

38. **Hectacma decoranda,** n. sp.

♂ ♀ 10-11 mm. Head, palpi, thorax whitish, palpi slender, second joint with several lateral projecting bristles towards apex, terminal joint shorter than second, filiform. Antennae nearly as long as forewings. Forewings elongate, apex pointed, produced, termen slightly sinuate, very oblique ; pale ochreous-yellowish with bases of scales grey ; a large acute wedge-shaped whitish patch based on basal third of costa with apex extending to disc at $\frac{2}{3}$, a white nearly longitudinal streak beneath posterior half of this, and separated from it by blackish ; a blackish blotch along basal fifth of costa ; costa from $\frac{1}{3}$ to apex white, between $\frac{1}{3}$ and $\frac{3}{4}$ with about eleven black more or less oblique strigulae arranged in three irregular groups ; an irregular white streak along termen, terminated above by a small black anteapical spot with an anterior projection margined beneath by a silvery mark, itself edged grey beneath (a fine grey line a little below this), and below middle immediately preceded by a rather larger black spot ; a black apical dot ; cilia light silvery grey, on costa a dark fuscous basal line towards apex, and dark fuscous projecting hook beyond it. Hind wings with 5 and 6 separate ; light brassy-grey ; cilia whitish-grey.

Mangere I., Manukau ; 4 ex. (Lindsay). This interesting and very distinct species has no near relationship to the several known New Zealand species of the genus, but seems much closer to *spartinodes* from Assam ; it would, however, be premature to assert that it may not itself be found in New Zealand

TINEIDAE.

39. **Trichophaga tapetiella** Linn. Taken by Fougère. A domestic species, widely distributed by man in Australia, New Zealand, and elsewhere.

40. **Monopis ethelella** Neom. Six normal examples taken by Fougère. Common in Australia and New Zealand, a domestic species. Mr. Lindsay appears to have spent his time in camp rather than in houses, which accounts for his not taking some insects of this class. The neuration of the forewings of this species (for comparison with the next) is 2 separate, 3 and 4 stalked, 6 and 7 short-stalked, 8 separate, 10 from angle, 11 from beyond $\frac{4}{5}$.

41. **Monopis typhlopa,** sp. n.

♀ 19-20 mm. Head whitish-ochreous. Palpi dark fuscous, apex whitish-ochreous. Thorax whitish-ochreous, patagia dark purplish-fuscous. Forewings with apex obtuse-pointed termen

very obliquely rounded ; 2 and 3 out of 4, 6 to costa, 7 and 8 stalked, 9 closely approximated, 10 nearly from angle, 11 from $\frac{2}{3}$; dark purplish fuscous ; a rather irregular-edged whitish-ochreous dorsal streak from base to tornus ; discal impression hardly marked, not hyaline ; costa obscurely freckled whitish-ochreous on posterior half ; cilia dark fuscous, base obscurely freckled whitish-ochreous, on tornus whitish-ochreous. Hind wings pale grey, with whitish-ochreous reflection ; cilia ochreous-whitish.

Mangere I. ; 3 ex. (Lindsay). Although at first sight similar to *ethelella,* this is really a very distinct species, by the absence of the hyaline impression (almost always well-marked in the genus), and the quite different neuration (which in this genus tends to be more or less peculiar in nearly every species).

42. **Tinea mysticopa** Meyr. Mangere I., 1 ex. (Lindsay). Also in South Island of New Zealand.

43. **Archyala terranea** Butl. Taken by Fougère ; common in New Zealand.

CADDIS-FLIES (ORDER TRICHOPTERA) FROM THE CHATHAM ISLANDS

By R. J. Tillyard, M.A., Sc.D. (Cantab), D.Sc. (Sydney), F.R.S., F.N.Z. Inst., F.L.S., F.G.S., F.E.S., C.M.Z.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson.

(With six Text-figures).

The very small collection of Caddis-flies dealt with in this paper consists of three specimens only, collected by Mr. Charles Lindsay during his visit to the Chatham Islands in December, 1923, and January, 1924. Each of the three specimens is of considerable interest, two being new species closely allied to two well known New Zealand species, and the third a very remarkable, short-winged, flightless form which requires a new genus and sub-family for its reception. It is much to be regretted that so few representatives of the Order were collected. In most Orders, the insects of the Chatham Islands show little differentiation from the New Zealand species; but it seems probable that this would not be the case with the Caddis-flies, and that a comprehensive collection of these insects would show a number of new and interesting forms.

I am indebted to Mr. A. Tonnoir for the drawings of figure 1.

Family RHYACOPHILIDAE.

Sub-family *HYDROBIOSINAE.*

Genus Hydrobiosis McLachlan.

Hydrobiosis lindsayi n. sp.

(Fig. 1).

♂ unique. Forewing 9.5 mm. Very closely related to the two New Zealand species *H. umbripennis* McL. and *H. frater* McL., but more especially to the former, with which it agrees in its general appearance and colouration. It is, however, considerably smaller in size, and an examination of the abdomen shows some well-marked differences in the form of the sternites, and also in the genitalia.

In *H. lindsayi,* n. sp., the penultimate sternite carries a medium-sized, sharply pointed, apical tooth; in *H. umbripennis* McL., there is a very much larger and stronger tooth; in *H. frater* McL., there are three small apical teeth, one on each of the last three sternites.

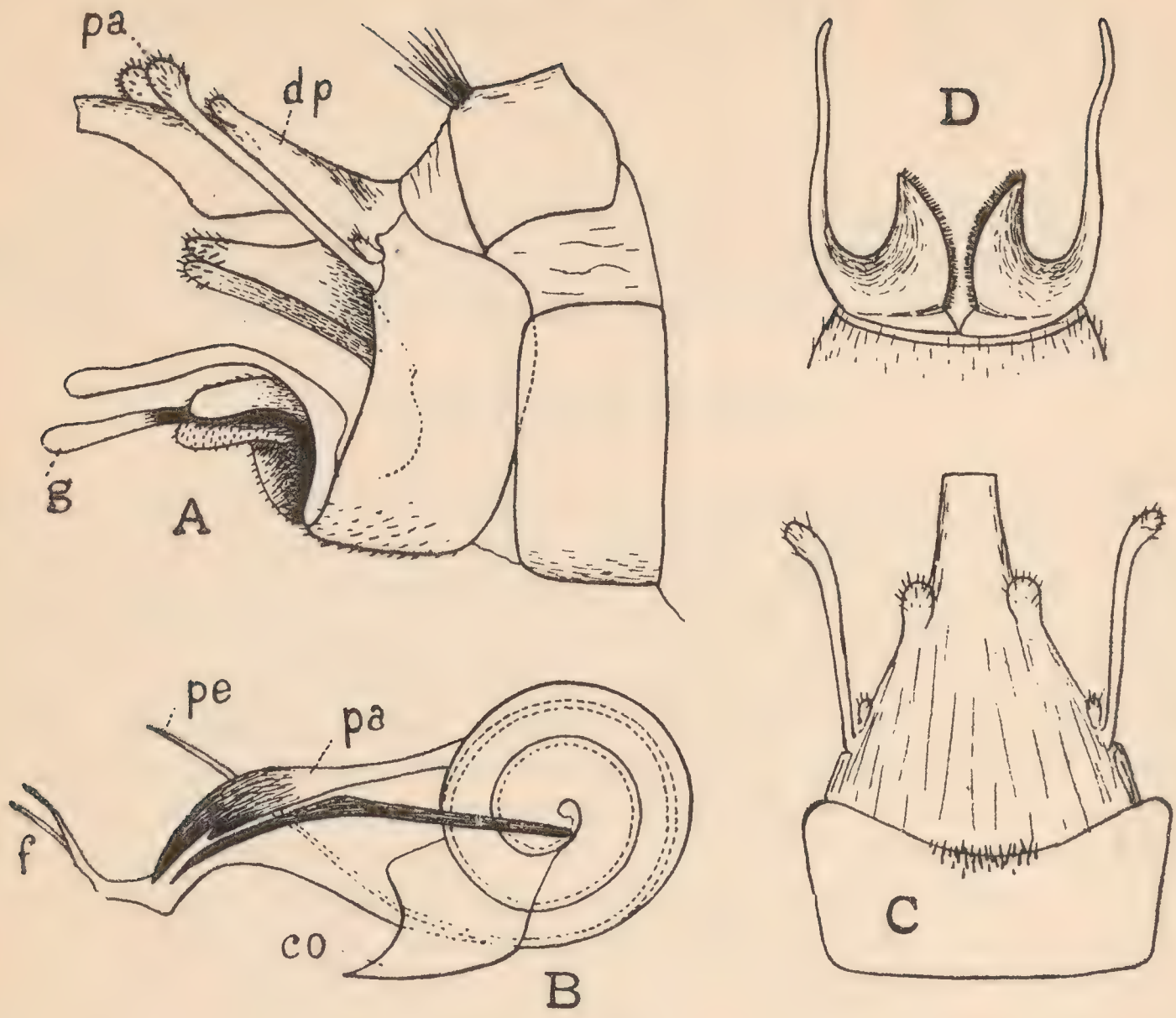

Fig. 1. *Hydrobiosis lindsayi* n. sp. Male genital appendages: A, lateral view, aedeagus removed, *dp* dorsal plate (tenth tergite), *pa* preanal appendages, *g* gonapophysis. B, aedeagus removed from the rest of the genitalia to which it is connected by means of the piece *co*, which is part of the 10th sternite, *f* bifid process of aedeagus, *pe* penis, *pa* parameres. C, Dorsal plate from above, D gonapophysis from below,

(Drawn by A. Tonnoir).

All species of *Hydrobiosis* have a long, slender penis, coiled up inside the abdomen in the form of a spring. This is well marked in the new species. The dorsal plate (*dp*) in the new species is long, somewhat irregular in shape, swollen in the middle and truncated at its apex; this is in marked contrast with the much more cylindrical dorsal plate of *H. umbripennis*; it shows on each side a small hairy tubercle, which may be the vestigial cerci. The preanal appendages (*pa*) are long, very slender and slightly knobbed, as in *H. umbripennis*, but their basal processes are much smaller and knob-like. In both species the aedeagus carries a peculiarly-shaped, slenderly bifid process (*f*). The form of the gonapophyses (*gp*) in the new species is very distinct, and they are very dark in colour.

TYPE.—*Holotype male* in Coll. Canterbury Museum; one pair of wings mounted on slide separately; abdomen detached, macerated in KOH, and mounted in glycerine jelly.

LOCALITY.—Waiparua, Chatham Is., Jan. 25th, 1924; taken by Mr. C. Lindsay.

This species is dedicated to its discoverer.

Sub-family *CHATHAMIINAE.*

A reduced offshoot from the Hydrobiosinae, characterised by the narrow wings and reduced venation, with not more than two apical forks present in either wing.

Genus CHATHAMIA n. g.

(Figs. 2, 3, 4).

Head (text-fig. 2, A, B) of irregular shape, with high, raised and rounded *frons*. *Labrum* with small pilifers. *Maxillary palpi* upstanding, the second segment elongate, the last three very small; *labial palpi* three-segmented, of normal form.

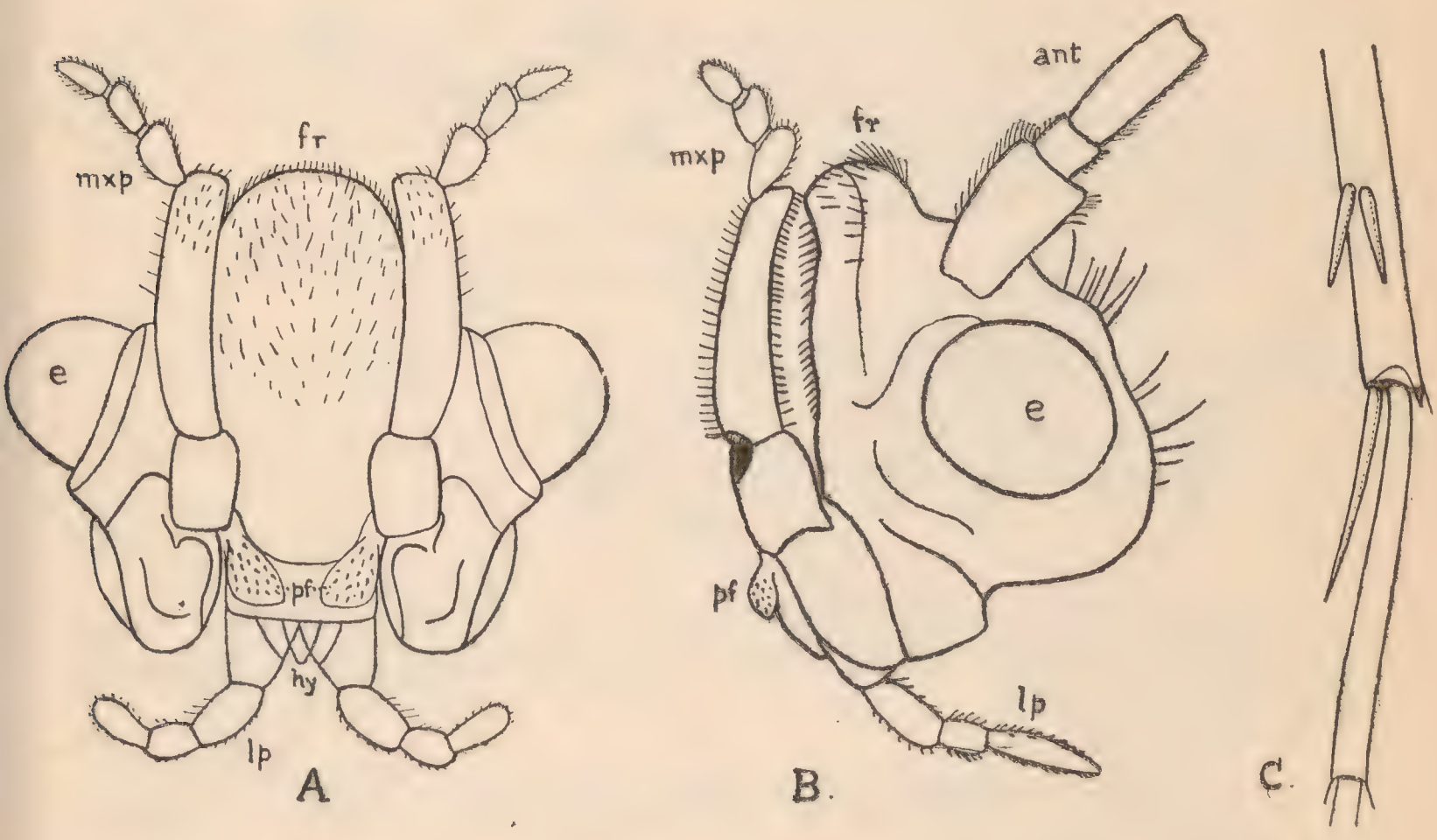

Fig. 2. *Chathamia brevipennis* n. g. et sp. A. Head, front view. B. Head, side view. C. Hind tibia and basal segment of hind tarsus, to show spurs. *Ant* antenna, *e* eye, *fr* frons, *hy* hypopharynx, *lp* labial palp, *mxp* maxillary palp, *pf* pilifers.

Thorax narrower than head. *Legs* well developed; *tibial spurs* 1, 2, 3, the hind tibiae having a pair of equal pre-apical spurs, a much longer inner apical spur, and a mere vestige of an outer apical spur (text-fig. 2, C).

Wings reduced in size and much narrowed, shorter than body. *Venation* reduced. Forewing with Sc, R1, part of Rs and whole of Cu1 well chitinized, and all of these, except Sc, carrying strong macrotrichia ; rest of venation not chitinized, only marked by the rows of macrotrichia along the courses of the veins ; no apical forks except Af5, which is obsolescent. *Hindwing* with weakly formed veins without strong macrotrichia ; apparently a small Af2 present just below apex and a narrow Af5 ; but the former may be due to fusion of R4 +5 partially with M, as it carries no wing-spot.

Abdomen of male with *genitalia* of peculiar form, suggesting a reduction from a Hydrobiosine type ; penis with large dorsal plate protecting it from above ; preanal appendages reduced ; gonapophyses of irregular form.

GENOTYPE.—*Chathamia brevipennis* n. sp.

Chathamia brevipennis n. sp.

(Figs. 2, 3, 4).

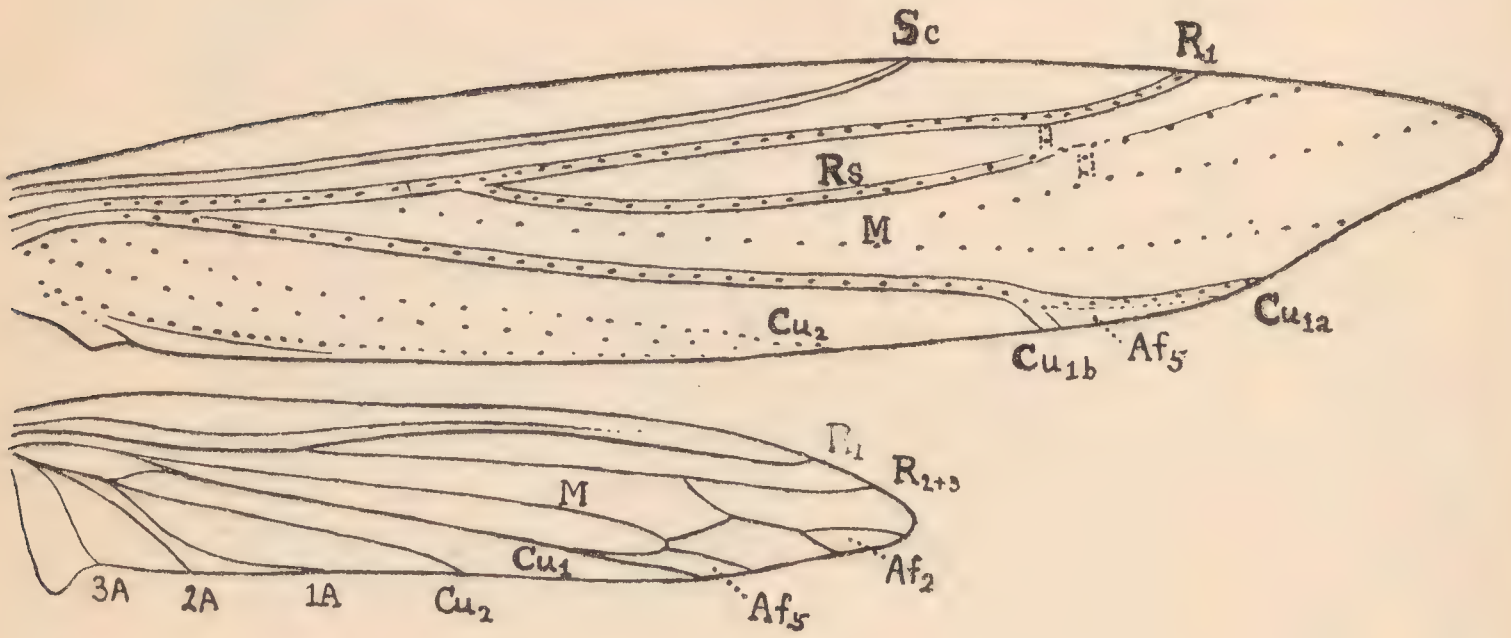

Fig. 3. *Chathamia brevipennis* n. g. et sp. Wings. Af_2, Af_5, second and fifth apical forks. Comstock-Needham venational notation.

♂ unique. Forewing 3.7 mm. (less than length of body) ; hindwing 2.0 mm.

General colouration blackish, the head dark brown, the legs and forewings fuscous, the hindwings subhyaline, slightly infuscated ; macrotrichia of forewing mostly blackish, very conspicuous.

Head (fig. 2, A, B) very large compared with rest of body and wings ; width across the very prominent eyes, 1.2 mm. *Antennae* 6.5 mm., stout, with 43 segments, the scape large, broad, half as long again as wide, the pedicel very short, much narrower than scape, the third segment about as long as scape, but same width

as pedicel, the fourth half as long as the third, the following segments to about the twentieth subcylindrical, subequal to fourth but very slightly narrowing and shortening, the remainder becoming submoniliform, the apical segment somewhat larger, oval; cilia on all segments very short. *Frons* very high and declivous anteriorly, rounded above, hairy. *Maxillae* with enlarged base projecting downwards and carrying a slightly hollow, pouch-like area; from above this rises vertically the very large maxillary palp, with short, stout first segment, greatly elongated second segment beset with short, stiff hairs, and three very short apical segments very loosely attached to seg. 2 and to one another; at base of seg. 2 and apex of seg. 1, externally, is a hard, black patch of chitin. *Pilifers* very small, mobile, sub-oval, with minute, short, thickened setae. *Labrum* wide, squarish. *Hypopharynx* short, weak, triangular. *Labium* wide, cleft medially, with normal, three-segmented palpi.

Thorax widest in front, about 0.8 mm. *Legs* with medium femora, slender tibiae and long, slender tarsi; hind tarsi very long; claws normal, empodium well developed. Text-fig. 2, C shows the formation of the spurs on the hind tarsus.

Wings (fig. 3) very narrow and reduced in length; *venation* as given in the generic definition. A reduced *jugal lobe* or fibula at base of forewing.

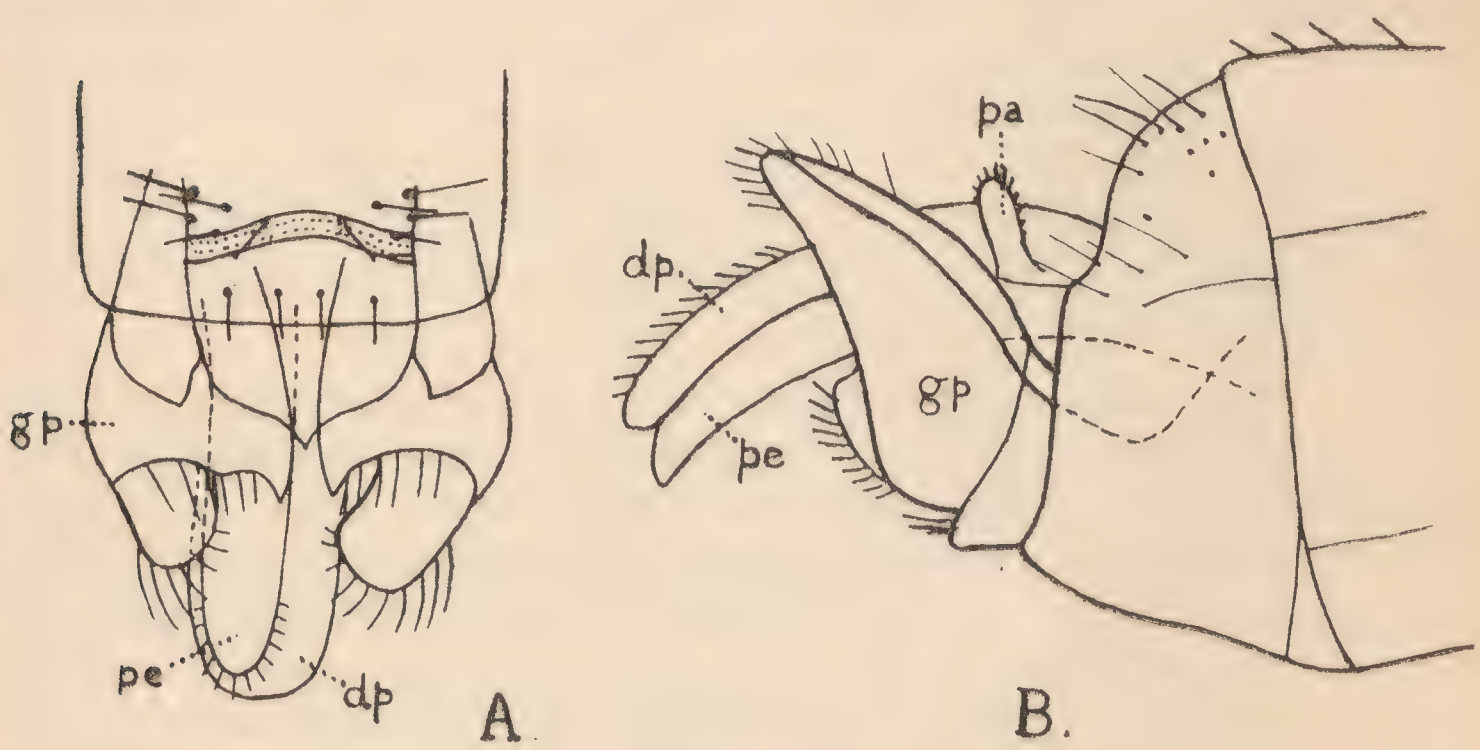

Fig. 4. *Chathamia brevipennis* n. g. et sp. Male genital appendages, A, ventral and B, lateral views; *dp* dorsal plate (tenth tergite), *gp* gonapophysis, *pa* preanal appendage, *pe* penis.

Abdomen.—Sternite 8 forms a rather small plate somewhat pointed apically, and carrying four stiff setae near base. *Genitalia* (text-fig. 4) with large, curved dorsal plate (*dp*), fairly wide, well rounded apically; penis (*pe*) about as long but narrower,

placed close below it. Preanal appendages (*pa*) very short, upstanding, slightly hairy. Gonapophyses (*gp*) large, irregular, apparently with a short basal segment and large curved distal portion, distinctly lobed ; the outer lobe large, somewhat flattened and rounded apically ; the inner lobe forming a short, sharply pointed process lying close to the mid-ventral line.

TYPE.—*Holotype male* in Coll. Canterbury Museum ; one pair of wings mounted on slide separately ; head and abdomen detached, macerated in KOH, and mounted separately in glycerine jelly.

LOCALITY.—Kaingaroa, Chatham Is., Dec. 25th, 1923 ; taken by Mr. C. Lindsay.

This species is one of the most remarkable caddis-flies ever discovered. The enormous head, remarkable, upstanding maxillary palpi, precipitous frons, reduced wings and venation, and peculiar male genitalia, all combine to give it a most extraordinary appearance, and to make its classification within the Order a most difficult task. The maxillary palpi at once suggest those of the males of Sericostomatidae, but the latter never have more than four segments. The narrow, reduced wings, with much reduced venation, cannot indicate Hydroptilid affinities, for they do not possess the long fringes and specialised upstanding macrotichia of that family. The key to the affinities of the insect appears to me to lie in the genitalia, where the large shield-like dorsal plate and the peculiar gonapophyses at once suggest a relationship with the New Zealand species of Hydrobiosinae ; this is further strengthened by the shape of the wings, which recall those of the genus *Tiphobiosis*, and by the presence of a reduced jugal lobe or fibula at the base of the forewing.

The Hydrobiosinae, however, form one subfamily of the archaic Rhyacophilidae, in all of which the venation is complete in both wings, with apical forks 1, 2, 3, 4 and 5 in forewing, and 1, 2, 3 and 5 in hindwing ; also the maxillary palpi in known species have seg. 2 always short. The specialization of the maxillary palpi in the present species, and the reduction of wings and venation, would preclude its being placed within the Rhyacophilidae at all. Nevertheless I feel sure that that is its correct position, and I propose to overcome the difficulty by forming a new subfamily for its reception, and by enlarging the definition of the family to include, as a stated exception, the species here described.

The only other alternative is to form a new family for it ; but this, I think, is unnecessary, seeing that the characters which separate it from the Rhyacophilidae proper are due to marked and evidently evolutionarily rapid degeneration of the wings and high specialization of the palpi.

Family LEPTOCERIDAE.

Genus OECETIS McLachlan.

(Figs. 5, 6).

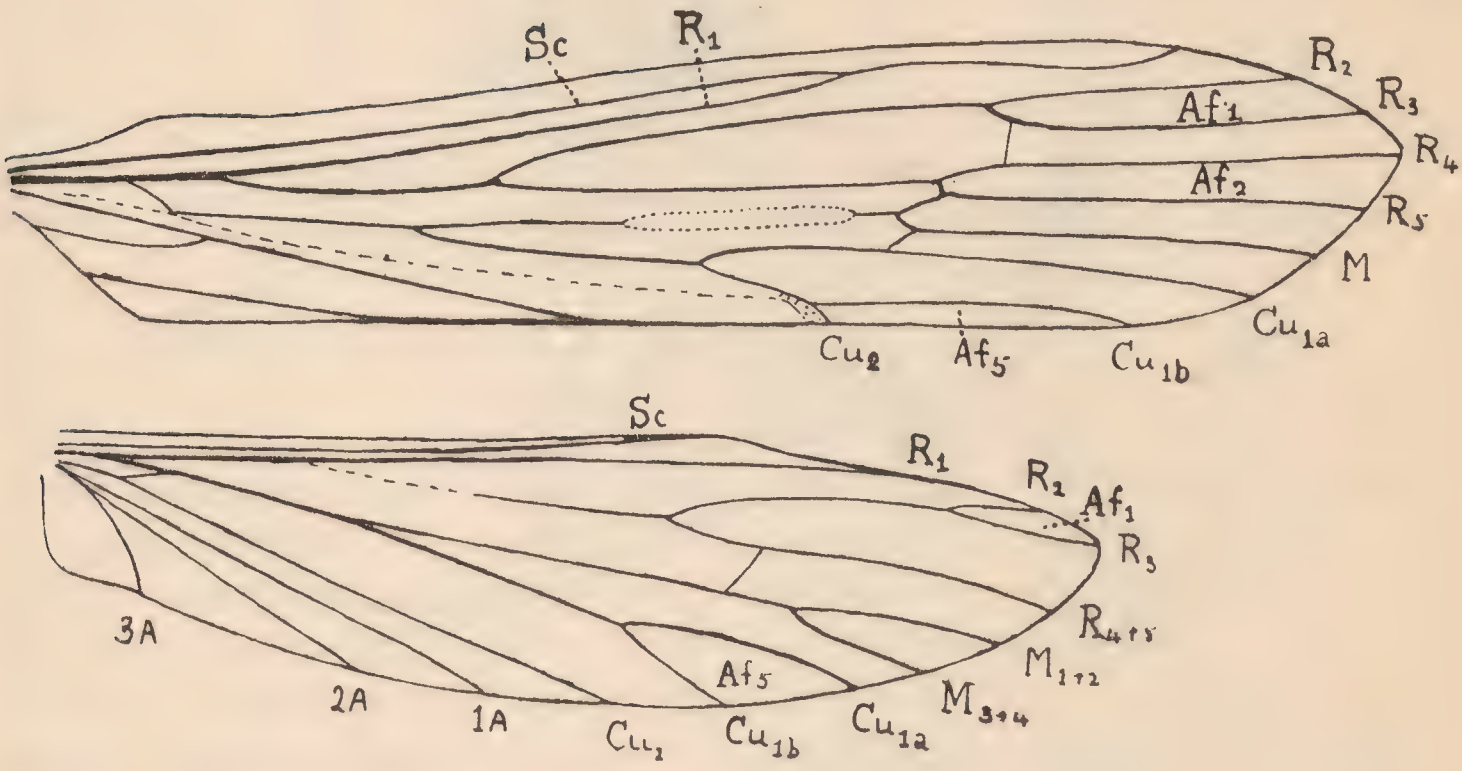

Fig. 5. *Oecetis chathamensis* n. sp. Wings. Af_1, Af_2, Af_5, first, second and fifth apical forks. Comstock-Needham venational notation. Note the thyridium indicated by dotted lines, about mid-way along M in forewing.

This is the only genus of the family of " Long-horned Caddises " known in New Zealand which has a narrow hindwing. The venation (text-fig. 5) is of considerable interest, the forewing having apical forks 1, 2 and 5 present, the last being very flattened, and the hindwing 1 and 5 only, and hence without a wing-spot. Radial (discoidal) cell of forewing is very long, closed. In both wings M fuses with Cu1 for a considerable distance ; in hindwing M is distally forked, but in forewing it is either simple, or its distal fork is obscured by fusion of its upper arm with R4 +5.

Oecetis chathamensis n. sp.

(Figs. 5, 6).

♂ unique. Forewing 9.2 mm. . Closely allied to the New Zealand species *Oe. unicolor* McL., but distinguished by the following characters :—

In the forewing (fig. 5) there are no dark spots such a sare conspicuously present in *Oe. unicolor ;* also there is a very narrow, elongate *thyridium* (or hyaline area in which the chitinization of a vein is lost) near the middle of vein M (fig. 5, dotted area).

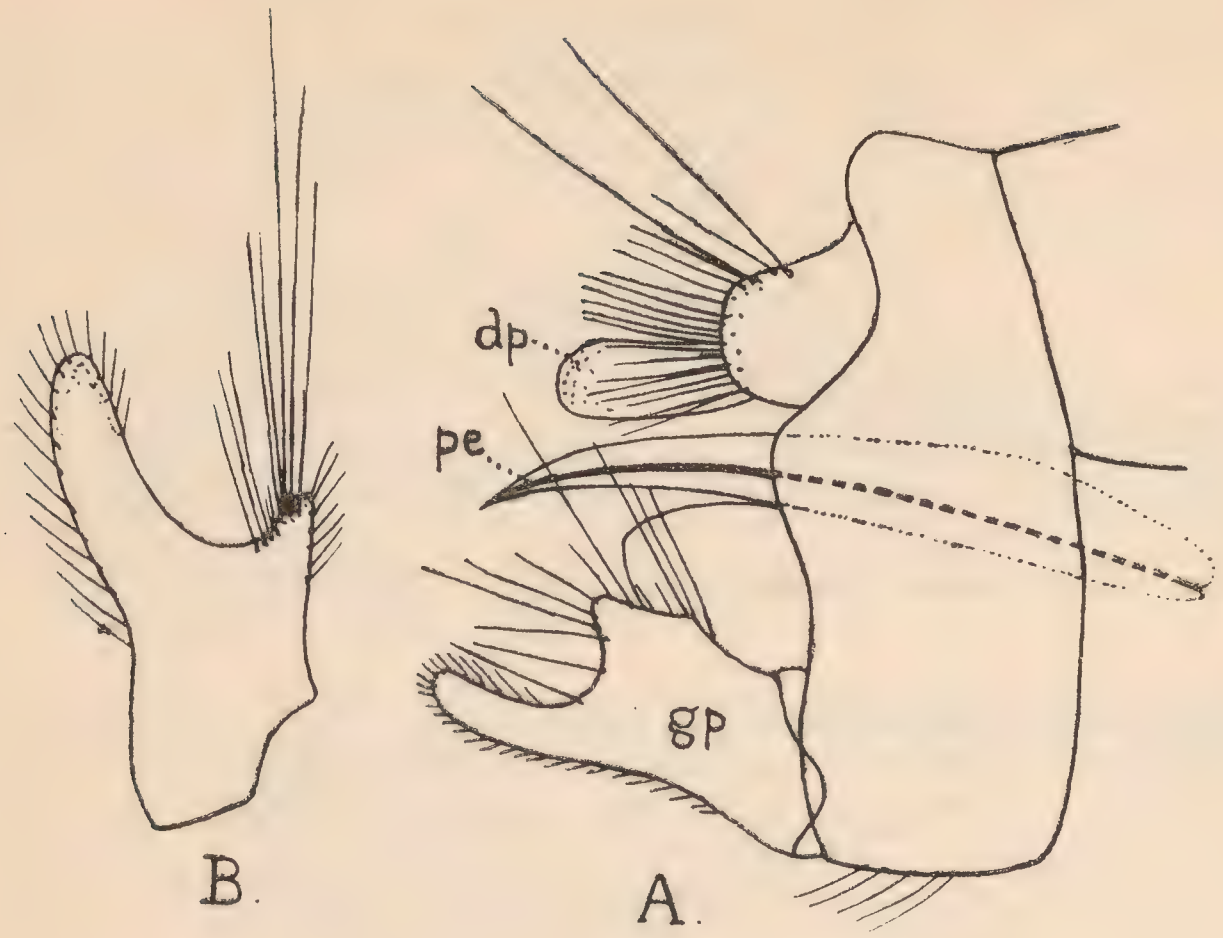

Fig. 6. *Oecetis chathamensis* n. sp., male genital appendages, lateral view ; *dp* dorsal plate, *gp* gonapophysis, *pe* penis. B. Lateral view of gonapophysis of *Oe. unicolor* McL. for comparison (same magnification).

The male genital appendages (fig. 6) resemble those of *Oe. unicolor* in general plan, but there are a number of marked differences. The genitalia of *Oe. chathamensis* n. sp. are on the whole smaller and less conspicuous ; the preanal appendages, which are long, cylindrical rods in *Oe. unicolor,* appear to be absent, or at any rate obsolescent, in the new species ; the penis in *Oe. unicolor* is exceedingly long and slender ; the gonapophyses (*gp*), though formed on the same plan in both species, differ considerably in the proportions of their lobes, as may be seen by comparing text-fig. 6, A and B ; in particular, the strong pencil of long stiff hairs, which is so conspicuous in the gonapophysis of *Oe. unicolor*, arising from near the apex of the inner lobe, is absent in the new species, being replaced by a series of much shorter and more scattered hairs.

Type.—*Holotype male* in Coll. Canterbury Museum ; one pair of wings mounted separately on slide ; end segments of abdomen detached, macerated in KOH, and mounted in glycerine jelly.

Locality.—The Ngaio, Chatham Is., Jan. 24th, 1924 ; taken by Mr. C. Lindsay.

Cawthron Institute, 26.3.25.

COLEOPTERA OF THE CHATHAM ISLANDS

By Albert E. Brookes.

Of the 110 species of beetles previously recorded from the Islands only 24 are represented in the collection before me. Two cosmopolitan Staphylinids and *Sessinia lineata*, all of which are also common to New Zealand, are recorded here for the first time. There are also two species of *Staphylinus*, which have their mandibles tightly closed, thus preventing their examination.* *Thelyphassa chathamensis*, described herein is the only species in the collection brought back that can be considered new to science, while three are doubtful, two being the *Staphylinus* mentioned above, and *Pheloneis* sp., the discovery of which is of special interest, being the first record of the genus from the Islands, although it is well represented in the Dominion. Some of the species appear to be rather common, and of these good series were obtained, but apparently no special effort was made to collect Coleoptera, which no doubt accounts for the few species obtained, otherwise more of the finer forms would most probably have been captured. Although eight representatives of the Carabidae have so far been recorded from the Islands, it is most remarkable that none were included in the collection under review. It is very probable that systematic collecting, carried out at the right time of the year, especially amongst leaf-mould, would produce a harvest of unrecorded species, and perhaps genera. Of the total number of species recorded from the Islands, more than half are also common to New Zealand. Only two endemic genera have so far been brought to light, viz., *Thotmus*, and the very fine *Hadramphus*, both of which belong to the family Curculionidae.

The system of classification adopted in this paper is that used by Dr. Leng in his "Catalogue of the Coleoptera of America North of Mexico," which is based on the Leconte classification, modified to accord with recent phylogenetic researches.

Where possible, I have given the tribes to which some of the species belong, but I have not been able to do this in all cases, owing to the necessary literature not being available.

The numbers used are those given to the various species by Broun, and are to be found in the last three papers referred to in the references cited. I have continued the system of numbering in the present paper, except for doubtful or exotic species.

For the major portion of the collection we are indebted to Mr. C. Lindsay, who at that time was on the staff of the Canterbury Museum, but now Taxidermist in charge of the Newtown Museum

*In this family it is essential that the mandibles be fully extended when setting out, and kept in that position until thoroughly dry, otherwise damage may result to the specimens in trying to separate them afterwards.

at Wellington, and for the larvae and spirit specimens to Mr. G. Archey, who was then assistant Curator of the same institution, and now Curator of the Auckland Museum, and also to Miss Fenwick of the Chatham Islands, for the collecting of several species. Due credit is given to all the collectors under their respective discoveries in the systematic list.

I also wish to thank Mr. A. L. Tonnoir, scientific assistant at the Canterbury Museum for the privilege of examining the present collection, and also those specimens previously contained in the Museum collection, which have been of great assistance in the preparation of this paper.

For kindly help and valued suggestions in the preparation of some of the drawings I am also indebted to Mr. Tonnoir, also to Mr. G. Archey for supplying botanical names.

Group STAPHYLINIFORMIA.

Sub-order POLYPHAGA.

Super-family STAPHYLINOIDEA.

Family STAPHYLINIDAE.

Sub-family *STAPHYLININAE.*

Tribe *Xantholinini.*

Xantholinus punctulatus Paykull.

One specimen submitted from the Hutton collection. This species has a wide range, and is now recorded for the first time from the Islands.

Tribe *Staphylinini.*

Staphylinus.

Three specimens belonging to two distinct species, which at present I am unable to determine, whether they will eventually prove to be endemic or introduced species remains a matter of doubt.

LOCALITY.—Mangere Island, collected by Mr. C. Lindsay between the 4th and 21st of January, 1924.

No. 4 **Creophilus oculatus** Fabricius.

LOCALITY.—Mangere Island, two specimens collected by Mr. C. Lindsay between the 4th and 21st of January, 1924.

Tribe Quediini.

No. 52 **Quedius antipodus** Sharp.

LOCALITY.—Mangere Island, one specimen collected by Mr. C. Lindsay between the 4th and 21st of January, 1924.

Quedius fulgidus Fabricius.

Three specimens submitted from the Hutton collection; no locality given. This is another cosmopolitan species, and another new record for the Islands.

Group SERRICORNIA.

Super-family MORDELLOIDEA.

Family OEDEMERIDAE.

No. 107 **Sessinia lineata** Fabricius.

LOCALITIES.—Owenga, one specimen, collected by Miss Fenwick, January, 1924, The Ngaio, one specimen, collected by Mr. C. Lindsay on the 24th of January, 1924. There were also two specimens submitted from the Hutton collection, without localities. This is another new record for the Islands.

No. 108 **Thelyphassa chathamensis** n. sp. (Plate xli., fig. 4).

Fulvo-testaceous, antennae and legs more pallid. Head and thorax moderately finely and closely punctate, the epistome slightly irregularly elevated, with a broad obscure channel reaching from a line between the antennae, to about the centre of the eyes on either side. Base of head with a distinct short groove. Antennae finely setose, basal joint moderately stout, second half the length of third, joints 3-6 sub-equal, 7-11 gradually decreasing. Palpi moderately stout, terminal joint of ♂ with an external broadly rounded excision.

Thorax with a distinct dorsal ridge, longer than broad, widest before the middle, its sides bisinuate, apex truncate, anterior angles rounded, base margined, a little obliquely incurved to the middle, posterior angles broadly rounded, dorsal area and lateral margins infuscate. Elytra three and one-fifth times as long as thorax, gradually rounded to beyond the hind thighs, and then very broadly, slightly narrowed to the extremities, apices individually rounded, not covering the terminal ventral segments, humeral angles obliquely rounded. Each elytron bears four distinct costae, rounded together and leaving a clear apical margin, interstices moderately broad slightly convex, their striae fuscous, and indefinitely punctate. The costae are slightly obliquely directed backwards towards the suture, the fourth beginning at the humeral angles. The whole surface is finely rugosely sculptured, and sparsely clothed with very short pallid hairs, and bears a somewhat varnished appearance. Scutellum punctate, transverse, curvilinearly triangulate.

Underside more finely sculptured than upper surface, basal ventral segments sub-truncate, penultimate semi-circular, terminal deeply incised, its lobes concave on the inner side.

Holotype ♂ Length, 7 mm., breadth, 2mm., Mangere Is., 4-21, January, 1924, C. Lindsay. In coll. Canterbury Museum.

Allotype ♀ Length, 7.5 mm., breadth, 2.5 mm. Mangere Is., 2nd January, 1924, C. Lindsay. In coll. Canterbury Museum.

Epistome, thorax, anterior and intermediate legs a little rufescent. Abdominal segments truncate, last ventral exposed, not covered by the elytra in either sex.

Paratopotypes in the author's collection :—Two specimens of both sexes, collected by Mr. C. Lindsay between the 2nd of December, 1923, and the 21st of January, 1924.

Remark.—This is a very distinct species, and should be readily identified by its rather conspicuous elytra. Also one specimen in spirit, collected by Mr. G. Archey, Curator of the Auckland Museum, at Wharekauri in December, 1923.

Super-family ELATEROIDEA.

Family ELATERIDAE.

No. 14 **Thoramus laevithorax** White. Pl. xli., fig. 1, 2, 3 ; g.c. xlii., fig. A, B, C.

Localities.—Kaingaroa, and Mangere Island, three specimens of the typical form.

Var. Thorax more finely and closely punctate, and has a little in front of the middle, on either side, a sub-circular glabrous spot. Elytra, and especially the head and thorax densely clothed with fine, light tawny, vestiture.

Locality.—Kaingaroa, one specimen, collected by Mr. C. Lindsay with the typical form, between the 25th of December and the 24th of January, 1923-24. Two specimens in spirit, together with three specimens of its larvae, and one pupa were obtained by Mr. G. Archey, Curator of the Auckland Museum, who cut them out of Matipo (*Suttonia chathamica*) at Kaingaroa, on the 25th of December, 1923.

Description of larva.—Head dark red-brown, mandibles short, head narrower than first thoracic segment, the segments gradually increasing in width to the seventh, and then very slightly decreasing to the last. Terminal process curvilinearly sub-triangular, with its apex a little truncate, upper surface sculptured, base punctate, then becoming pustular, increasing in size posteriorly until they evolve into short blunt spinous processes, the two situated at the posterior angles largest and bifid, upper surface and lateral margins setose. A portion of the dorsal area of all the segments, except thoracic, ornamented with short spicules, which are more prominent on the first five. The first thoracic segment about twice the length of the following two, which are sub-equal ; it has a broad dark brown band, reaching only to the lateral edges, second and third with narrower and shorter bands, each with a pair of very short legs (see figs. 1, 2, 3 and A, B, C, plates xlii. and xliii.).

No. 15 **Mecastrus convexus** Sharp.

LOCALITIES.—Mangere Island, two specimens; Owenga, one specimen, collected by Mr. C. Lindsay between the 2nd and 24th of January, 1924.

Group CLAVICORNIA.

Super-family CUCUJOIDEA.

Family OSTOMIDAE.

No. 42 **Leperina shandi** Broun.

A good series of the typical form were obtained, also two specimens of a smaller variety devoid of vestiture, and three specimens of what appear to be Brouns' var. a. Broun states (T.N.Z.I., vol. xlii., 1909, p. 307) :—" This may prove to be a distinct species," but I do not see anything in the specimens before me to warrant specific distinction.

LOCALITIES.—Kaingaroa and Mangere Island, collected by Mr. C. Lindsay between the 25th of December and the 21st of January, 1923-24.

Family HEMIPEPLIDAE.

No. 8 **Diagrypnodes wakefieldi** Waterhouse.

LOCALITY.—Kaingaroa, one specimen, collected on the 25th of December, 1923, by Mr. C. Lindsay. Also two specimens in spirit from Maunganui, collected by Mr. G. Archey, Curator of the Auckland Museum on the 16th of December, 1923.

Family COLYDIIDAE.

No. 57 **Enarsus bakewelli** Pascoe.

LOCALITY.—Mangere Island, one specimen only, collected by Mr. C. Lindsay between the 4th and 21st of January, 1924.

Tribe *Pycnomerini*.

No. 62 **Pycnomerus mediocris** Broun.

LOCALITY.—Whangamarino Hill, 700 feet, three specimens in spirit, collected by Mr. G. Archey on the 28th of January, 1924.

Family COCCINELLIDAE.

Coccinella 11-punctata Linnaeus.

LOCALITIES.—Mangere Island, three specimens; Maunganui, one specimen, collected by Mr. C. Lindsay, between the 16th of December and the 21st of January, 1923-24.

Super-family TENEBRIONOIDEA.

Family HELEIDAE.

No. 19 **Cilibe saragoides** Pascoe.

LOCALITY.—Wharekauri, four specimens.

No. 20 **Cilibe subcostatus** Sharp.

LOCALITY.—Mangere Island, a good series. This and the preceding species were collected by Mr. C. Lindsay between the 14th of December and the 21st of January, 1923-4.

REMARK.—The other member of the genus, *C. pascoei* Bates, also recorded from the Islands is apparently not so common, and was not included in the collection.

Sub-family *HELOPINAE.*

Pheloneis sp.

LOCALITY.—Wharekauri, a single specimen of this genus was collected by Mr. C. Lindsay on the 14th of December, 1923.

REMARK.—As the specimen does not agree with any of the other members of the genus known to me, and the fact that a good deal of variation is apparent among individuals of the same species, I consider it advisable to let the specific determination stand over until such time as a series of the insect can be obtained and examined.

Group LAMELLICORNIA.

Super-family SCARABAEOIDEA.

Family SCARABAEIDAE.

No. 12 **Odontria zealandica** White.

LOCALITY.—Wharekauri, a single specimen, collected by Mr. C. Lindsay on the 14th of December, 1923.

Family LUCANIDAE.

No. 9 **Lissotes capito** Deyrolle.

LOCALITY.—Manuporu, three ♂♂, collected by Mr. C. Lindsay on the 2nd of January, 1924.

No. 43 **Lissotes dispar** Broun.

LOCALITY.—Mangere Island, three ♂ ♂, and one ♀, also collected by Mr. C. Lindsay between the 4th and 21st of January, 1924.

REMARKS.—This is a larger species than the closely allied preceding one, and can be distinguished by its irregularly impressed thorax. The reflexed right mandible is not a constant character. Apparently the ♂ ♂ of the genus are much more common than the opposite sex, as six ♂♂ and only one ♀ were captured, which is now described below. Among the specimens in the Canterbury Museum collection, and submitted to me with the above, were a ♂ and ♀ bearing the label "*Lissotes antelope*, F. W. Hutton, det." I have not been able to trace this specific name (*), the ♂ specimen

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*Since the above was written I have come across the following reference :
White, 1846, Voy. Ereb. and Terr., Insects, p. 23.
Lucanus (Prionus ?) Antilope, Kerby, Zool. Journ. 11, 70, Pl. 1, f. 7.
The last reference is not available to me, and I cannot find the name in Gemminger and Harold's catalogue.

agrees with that of *L. dispar*, and the ♀ with that of *L. capito*. Mr. Lindsay also obtained several specimens of the larvae of one of the above species, probably that of *L. dispar*, on Mangere Island on the 14th of January, 1925.

Broun did not give a description of the ♀ of this species, owing no doubt to the want of specimens, so I am including a short diagnosis :—

Dark reddish chestnut, lower portion of legs and mandibles darker. Mandibles short, excavated on their upper edge and punctate, the right one broadly tridentate at extremity, left one hollowed to receive middle denticle of right. Head narrower than thorax, quadrately depressed in front for more than half its length, anterior portion of the sides more abruptly so, and hollowed in front of the eyes, front margin a little incurved, anterior angles obtuse, sides obliquely widened to the not prominent eyes, and then sub-parallel to the base, which has rounded angles ; in the angles of the frontal depressions there is a fuscous spot, and another smaller one on each of the ridges, which divide the lateral from the dorso-frontal portion. The whole surface coarsely punctate. Thorax broader than long, frontal and basal margins sub-truncate with the anterior angles produced, sides rounded, very slightly narrowed to the quadrate posterior angles, the surface is more remotely punctured than the head, and has two depressions near the base, one on each side of the middle, and another on each side a little in front, but more or less indistinct ; there is also a faint median line with a slight basal depression. Elytra slightly wider in the middle, but not wider than thorax at base, gradually rounded and narrowed to the apices, basal margin depressed, its angles produced, reflexed and bluntly rounded ; each elytron bears about four longitudinal slight elevations, the whole surface is moderately closely punctate. Scutellum transverse, closely rugose, punctate. Anterior tibia bidentate at the extremity, with four or five smaller ones higher up.

Allotype ♀ length, 19 mm. ; breadth, 9.6 mm.

LOCALITY.—Mangere Island, a single specimen collected by Mr. C. Lindsay between the 4th and 26th of January, 1924. The specimen which has to be considered as the allotype has been returned to the Canterbury Museum.

Sub-family *ÆSALINAE*.

No. 10 **Ceratognathus helotoides** Thomson.

LOCALITIES.—Whangamarino, Mangere Island, and Kaingaroa ; a good series were collected by Mr. C. Lindsay between the 4th and 21st of January, 1924. The majority of the specimens being ♀♀.

No. 11 **Mitophyllus reflexus** Broun.

LOCALITY.—Mangere Island ; a good series also collected by Mr. C. Lindsay with the foregoing. In this series the ♂♂ are more numerous.

Group PHYTOPHAGA.

Super-family CERAMBYCOIDEA.

Family CERAMBYCIDAE.

Sub-family *CERAMBYCINAE.*

No. 34 **Xuthodes punctipennis** Pascoe.

LOCALITY.—The Ngaio, one specimen, collected by Mr. C. Lindsay, on the 24th of January, 1924.

No. 35 **Xuthodes divergens** Broun.

LOCALITIES.—Mangere Island, and Owenga, one specimen from each, collected by Mr. C. Lindsay between the 2nd and 21st of January, 1924. Also one specimen from Owenga, collected by Miss Fenwick, during the same month.

Group RHYNCHOPHORA.

Super-family CURCULIONOIDEA.

Family CURCULIONIDAE.

Sub-family *CRYPTORHYNCHINAE.*

No. 26 **Psepholax sulcatus** White (Pl. xli., fig. 5, 6, 7).

LOCALITIES.—Mangere Island, a good series; Kaingaroa, one specimen, collected by Mr. C. Lindsay between the 4th and 21st of January, 1923. A number of specimens in spirit, with several larvae, were collected by Mr. G. Archey, Curator of the Auckland Museum, at Kaingaroa, who cut them out of Matipo on the 25th of December, 1923.

No. 27 **Aldonus hylobioides** White.

LOCALITIES.—Whangamarino, Maunganui, Owenga, and Mangere Island, a total of six specimens.

No. 28 **Aldonus chathamensis** Sharp.

LOCALITIES.—Maunganui, and Mangere Island, three specimens.

No. 44 **Aldonus misturatus** Broun.

LOCALITIES.—Maunganui, and Mangere Island, six specimens.

No. 45 **Aldonus lineifer** Broun.

LOCALITIES.—Maunganui, Owenga, and Mangere Island, five specimens.

All the specimens of the four species were collected by Mr. C. Lindsay between the 16th of December and the 28th of January, 1923-24.

REMARKS.—All the species of this genus from the Islands are undoubtedly very closely allied, and the separation of the material has given considerable trouble, owing to a certain amount of variation. *A. chathamensis* is the most easily recognised species.

Super-family SCOLYTOIDEA.

Family PLATYPODIDAE.

No. 31 **Platypus apicalis** White.

LOCALITY.—Te Whakaru, a single specimen (in spirit), boring in an apple tree, collected by Mr. G. Archey on the 27th of December, 1923.

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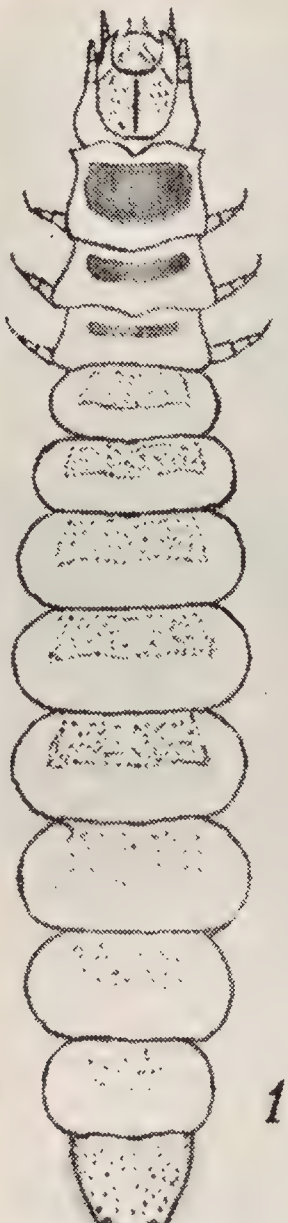
Broun, T., 1910—Additions to the Coleopterous Fauna of the Chatham Islands, T.N.Z.I., vol. xliii., pp. 92-115.

EXPLANATION OF PLATES XLI. AND XLII.

Fig. 1—*Thoramus laevithorax*, White, larva x 2.
Fig. 2 ,, ,, ,, pupa x 2.
Fig. 3 ,, ,, ,, imago x 1½.
Fig. 4—*Thelyphassa chathamensis*, n. sp. ♂ x 4.
Fig. 5—*Psepholax sulcatus*, White, larva x 2.
Fig. 6 ,, ,, ,, pupa x 2.
Fig. 7 ,, ,, ,, imago x 2.
Fig. A—*Thoramus laevithorax*, White, larva, head.
Fig. B ,, ,, ,, 4th abdominal segment.
Fig. C ,, ,, ,, terminal process.

PLATE XLI.



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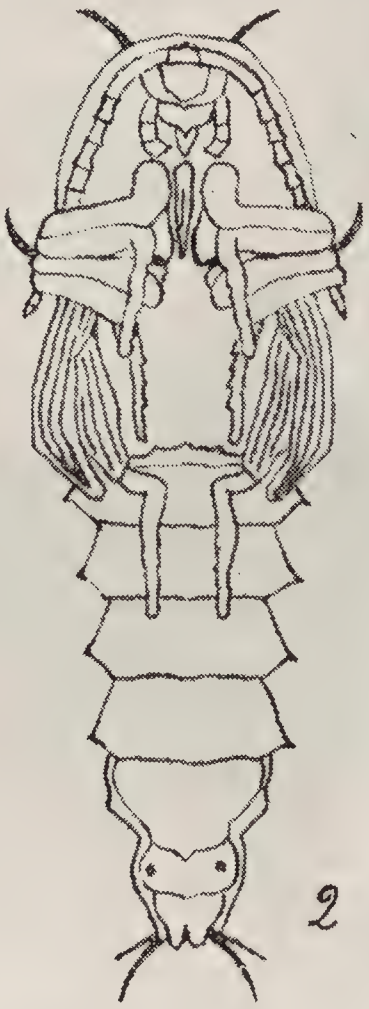

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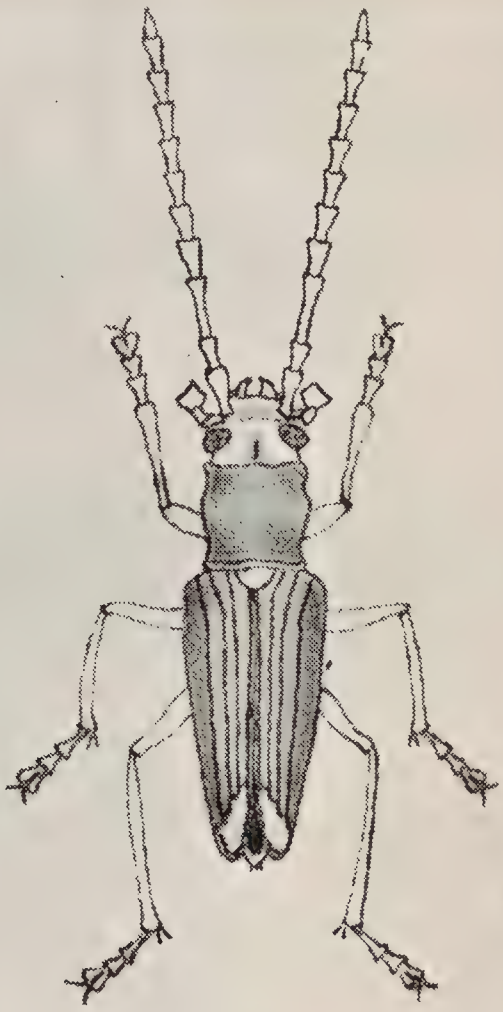

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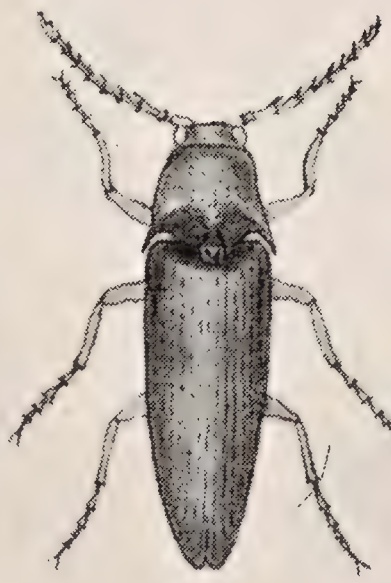

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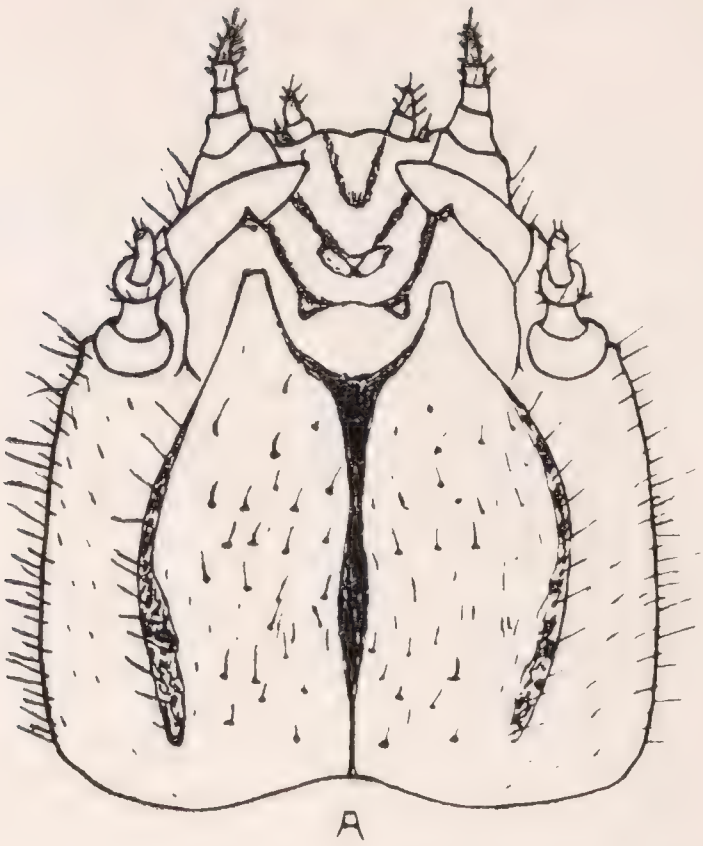

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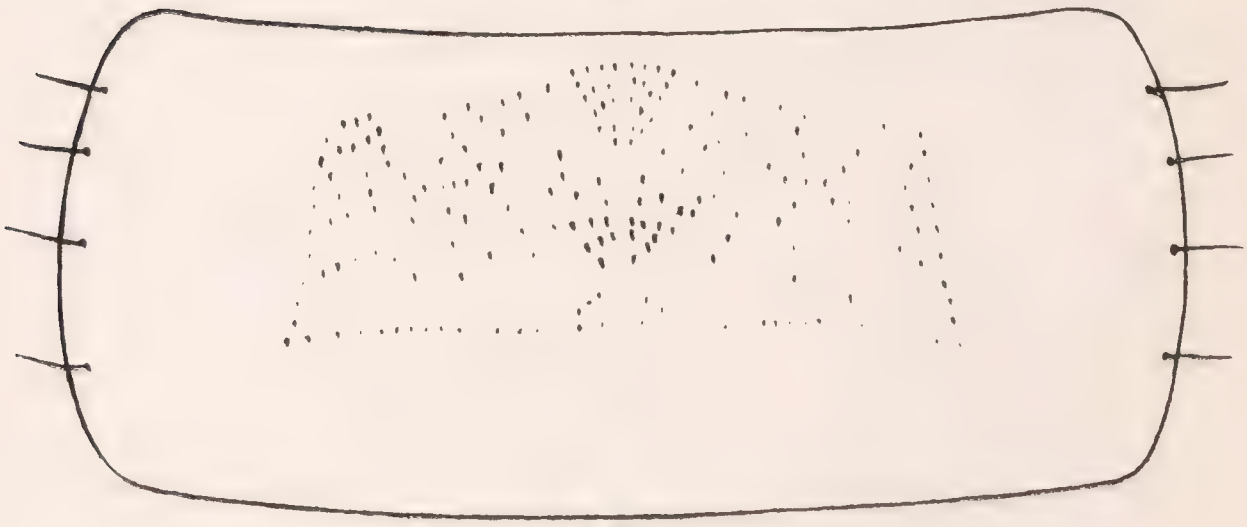

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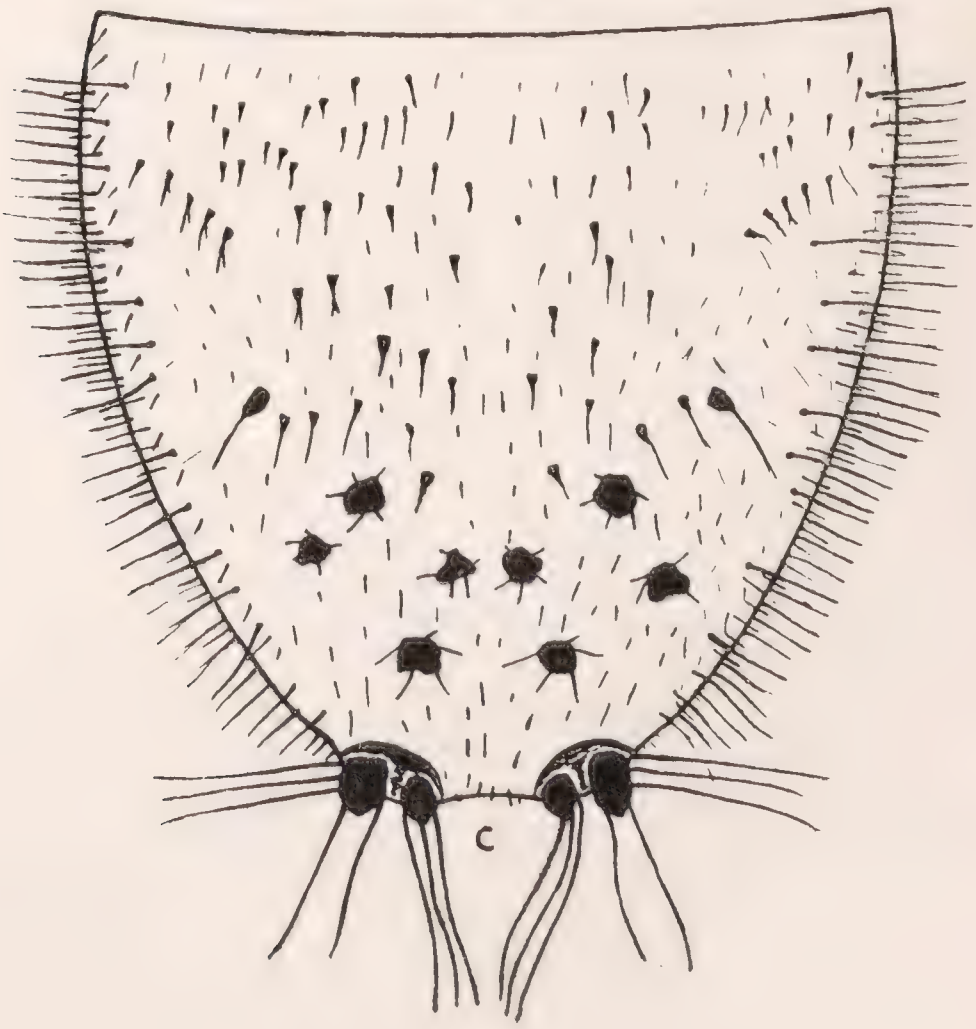

C

SPIDERS OF THE CHATHAM ISLANDS*

By Lucien Berland.
(Paris).

The spiders of the Chatham Islands have been studied by E. Simon in two memoirs (1899 and 1905), and more recently partly by Comte de Dalmas (1918). The following list is actually known :—

1. *Ixeuticus chathamensis.*
2. *Ariadna barbigera.*
3. *Theridion tepidariorum.*
4. *Tetragnatha gulosa* [1].
5. *Araneus verrucosus.*
6. *Clubiona peculiaris.*
7. *C. cambridgei.*
8. *C. chathamensis.*
9. *Desis marinus.*
10. *Cambridgea antipodiana.*
11. *Mynoglenes insolens.*
12. *Tegenaria domestica.*
13. *Dolomedes schauinslandi.*
14. *Lycosa hilaris.*
15. *L. ralphi.*
16. *L. turbida.*
17. *L. retiruga.*
18. *L. algida.*

To this list I add two species that I am obliged to consider as new :—

19. *Linyphia antipodiana.*
20. *Lycosa maunganuiensis.*

The species 1, 4, 5 and 10 are very numerous, and seem to be predominant in the aranean fauna of these islands. The families Agelenidae and Lycosidae are particularly well represented ; on the contrary the family Salticidae is totally wanting, and this fact is remarkable, these spiders being numerous and widely distributed.

The affinities of the spiders of the Chatham Islands are entirely with New Zealand, where the same species, or very near related ones are found. There is no affinity with America. It is known, after the studies of H. R. Hogg, that on the contrary, the spiders of the Sub-antarctic Islands (Campbell, etc.) seem to present a certain relationship with those of South America.

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* This account is based on a collection made in the Chatham Islands by Messrs. Archey and Lindsay during the months of December, 1923, and January, 1924. R. S.

(1) Tetragnatha nitens.

Ixeuticus chathamensis Simon.

(Plate xliii., figs. 1-5).

Amaurobius chathamensis Simon, 1899, p. 433 ; 1905, p. 416.

Ixeuticus chathamensis Dalmas, 1918, p. 334.

There are no true *Amaurobius* in Oceania ; this species belongs to the group *Dictynidae,* closely allied to *Amaurobius ;* the former has a calamistrum composed of one row of hairs, whereas it has two rows in *Amaurobius* (see de Dalmas, 1918, p. 330, Berland, 1924, p. 177-184). Many genera were created by E. Simon (1908) for the Australian forms of this group. *I. chathamensis* comes quite near to *Epimecinus,* but differs from it by the teeth of the chelicerae (fig. 4). De Dalmas proposed (1918, p. 329) the genus *Ixeuticus,* in which he placed all the New Zealand species formerly included in *Amaurobius,* and also *chathamensis.* I follow him because the type of this genus seems to be *I. martius* Simon (1), to which *chathamensis* is very closely related, chiefly in the character of the disposition of the eyes, which is of the greatest importance for these spiders. But I think that the genus *Ixeuticus* is not sufficiently definite, and if we take for its characters those of *I. martius,* we are obliged to conclude that many species admitted by de Dalmas as *Ixeuticus* do not belong to it. A complete study of the Oceanian *Dictynidae* of this group would be most useful.

In the description of *T. chathamensis,* Simon writes :—" Oculi cuncti parvi, interse subaequales." But in fact the median anterior eyes are always smaller than the others, as I have noted on examining the type-specimens ; Simon himself rectified it (1905, p. 416).

I may add that the body and the legs bear long, black, fine, bristly hairs.

Locality.—Chatham Islands, many ♂ ♀ ; seems to be one of the commonest spiders of the Islands.

Linyphia antipodiana, sp. n.

(Plate xliii., figs. 6-10).

♀ (Fig. 6). Total length, 5.5 mm.

Colour.—Cephalothorax light yellowish brown, darker in front with greyish lines starting from the central stria ; eyes lightly encircled with black ; chelicera reddish brown, sternum yellowish brown, the margin grey, legs pale yellow, with more or less distinct greyish rings ; abdomen testaceous above with two longitudinal blackish irregular lines, often broken, the sides with a silvery net, ventral surface with a big triangular silver spot, the base touching the genital furrow, the summit reaching the spinnerets ; the sides of this triangle are fringed with black.

(1) It is the first species mentioned, but it is not expressly indicated as the genotype.

Eyes.—First row curved, median small, quite near each other, but widely separated from the lateral; second row straight, the eyes equal, median distinct from each other by half their diameter, but more than a diameter from the lateral; median ocular group longer than wide, and narrower anteriorly (fig. 7).

Chelicera vertical, strong, slightly inflated at the base, anterior border with four or five teeth, the median stronger, posterior border with many very small teeth.

Legs moderately long, bearing very few spines; femora spineless, except femora I., tibia I., with one median inferior spine and one anterior, tibia II., with two inferior and one anterior spines, tibia III., with one median inferior and two apical spines, tibia IV., with three inferior spines; metatarsi I. and II. without spines, III. and IV. with an apical verticil of spines and some others (see fig. 6).

Epigyna (fig. 8), a little grey horseshoe-like piece receiving in its concavity an angular projection of the genital groove; two long sinuous black spots are seen under the skin.

♂ Total length, 5 mm.

Colour of the female; cephalothorax, chelicera, and sternum reddish-brown.

Pedipalps (fig. 9 and 10), tibia without apophysis, paracymbium hook-like, acute at the summit and with a small rounded apophysis near the base; apical apophysis black, long, sinuate; stylus long, fine, looped, issuing at the base from the bulb on the internal side (fig. 10).

Maunganui, 2 ♂, 6 ♀ (types).

This species is quite near our *Linyphia*, but it differs from them by the disposition of the eyes and by the very scanty spines of the legs. If it was a European species it would perhaps not be put in the genus *Linyphia;* by its eyes it comes nearer *Stemonyphantes*. This spider was not found in the Chatham Islands by Schauinsland; if it is not indigenous, its origin is nevertheless difficult to point out, but it is perhaps not without interest to remark that it seems to be reminiscent of some *Linyphia* described by Tullgren from South America.

Fig. 8 represents the aspect of one of the specimens, chosen for the description, some others are grey, and have the abdominal markings and leg rings less distinct.

Tetragnatha nitens Audouin.

Awanata Creek 27.I. 24, 1 ♂ 2 ♀; Kaingaroa, 25.XII. 23, 1 ♂ 2 ♀; Maunganui, 17.XII. 23, 2 ♂ 3 ♀, many young forms.

Recorded by Simon from the Chatham Islands under the name of *T. gulosa* L. Koch; de Dalmas (1918, p. 365) established the synonymy. This species is nearly cosmopolitan.

Araneus pustulosus Walckenaer.

Te Whaka Hill (bush), 28.I. 24, 4 ♀ ; Te Awatea, 23.I. 24, 1 ♀ ; Maunganui (rock shelter), 19.XII. 23, 3 ♂, 1 young.

Common, known also from Auckland Islands, Campbell Islands, New Zealand, Tasmania, Australia. Recorded by Simon from the Chatham Islands under the name *verrucosus* Walckenaer ; de Dalmas (1918, p. 379) established the synonymy.

Cambridgea antipodiana White.

Subsp. **annulata** Dalmas.

De Dalmas, 1918, p. 402 ; p. 400, fig. 64.

Whangamarino Hill (bush), 700 feet, 28.I. 1924, 1♀ ; Kaingaroa (bush), 24.X.11, 1923, 1 ♀, 1 young ; Owenga (plateau bush), 3.I. 1923, 1 ♂ ; Wharekauri, 14.X.11, 1923, 1 ♂, 1 ♀ ; Maunganui, 14.X.11, 1923, 2 ♂ (sub-adult), 2 ♀ ; Mangere Island, 6-10.I. 1924. 1 ♂, 7 ♀.

This is the commonest spider of the Chatham Islands. Until quite recently the genus *Cambridgea* was confined to New Zealand, where it is as common as in the Chathams ; but I have described recently another species, found in New Caledonia by Sarasin and Roux (1924, p. 237).

The *Cambridgea* are nearly allied to *Argyroneta*, the well-known aquatic spider, and it was thought that they might have the same habits. But Count de Dalmas found in New Zealand that their behaviour was quite different, and that they live like our *Tegenaria* or *Agelena*, that is to say that they make a horizontal web in the houses, in the bushes, or at the foot of the trees (1918, p. 398). As in *Argyroneta*, the male is bigger than the female, which is quite an exception amongst spiders.

The specimens from Wharekauri are smaller than the others, although perfectly adult.

Lycosa maunganuiensis, sp. n.

(Plate xliii., figs. 11-15).

♀ (Fig. 11). Total length : 9 mm. ; carapace, length : 4 mm. ; breadth, 3.5 mm.

Colour.—Cephalothorax brown, with a thin marginal black line, and black radiant lines ; a median longitudinal whitish stripe extends from behind the eyes to the posterior margin ; this stripe is slightly widened posteriorly, and much enlarged in front ; eyes encircled with black ; chelicera dark reddish, with black stripes ; mouth parts dark reddish, paler at the apex ; sternum brown with a whitish median line, not reaching the hind margin ; legs pale yellow or reddish, with strong brown rings ; abdomen black on the back,

with some very dark reddish markings (fig. 11), ventral face reddish, with a median longitudinal black stripe not reaching the spinneret (fig. 12) ; these are dark brown.

Cephalothorax low and broad in front, the eyes occupy only a part of its breadth (a little more than the third) ; face without distinct superior angles.

Eyes.—First row slightly procurved, its eyes nearly equal, the median much nearer to each other than to the lateral eyes, the distance between the median and lateral eyes being about their diameter, the distance between the two median less than half their diameter ; second row as broad as the first one, its eyes very large, separated from each other by a distance about equal to their diameter ; third row broader than the second, its eyes a little smaller (fig. 13).

Chelicera distinctly overlapping the frontal edge, anterior border with three teeth, the median stronger, posterior lower with two equal teeth (fig. 14).

Legs strong, covered with bristly hairs and bearing a few spines on the superior face of the femora (probably only two), and a few more (1-2-2 or 2-2-2) on the inferior face of the tibiae and metatarsi, a verticil of spines at the apex of metatarsi.

Epigyne (fig. 15).—Difficult to see, the specimens having laid their eggs, the abdomen is somewhat retracted.

Chatham Islands : Maunganui, 2 ♀ (types).

This spider belongs to the group *Lycosa terricola* (subgenus *Trochosina* of Simon) ; this group of species, with only two teeth on the posterior border of the chelicera, is rather numerous in New Zealand, and well represented in the Chatham Islands, but the present specimens did not agree with any known species, which is the most curious, as five *Lycosa* have already been described or recorded from this small archipelago. *L. maunganuiensis* is quite peculiar in the disposition of the first row of eyes ; it is very rare to see the median eyes so far distant from the lateral ones, and I think that this character warrants considering the species as a new one.

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EXPLANATION OF PLATE XLIII.

Ixeuticus chathamensis Simon.

Fig. 1—♂, copulatory organ.

Fig. 2—♂, tarsus of the palpus, side view.

Fig. 3—♀, eyes seen from above.

Fig. 4—♀, chelicera.

Fig. 5—♀, epigyne.

Linyphia antipodiana sp. n.

Fig. 6—♀, x 5.

Fig. 7—♀, eyes seen from above.

Fig. 8—♀, epigyne.

Fig. 9—♂, copulatory organ seen from the external side.

Fig. 10—♂, stylus of the copulatory organ.

Lycosa maunganuiensis sp. n.

Fig. 11—♀, x 5.

Fig. 12—♀, ventral face of the abdomen.

Fig. 13—♀, eyes seen from above, and supposed to be in an horizontal plane.

Fig. 14—♀, chelicera.

Fig. 15—♀, epigyne.

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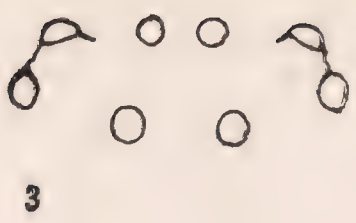

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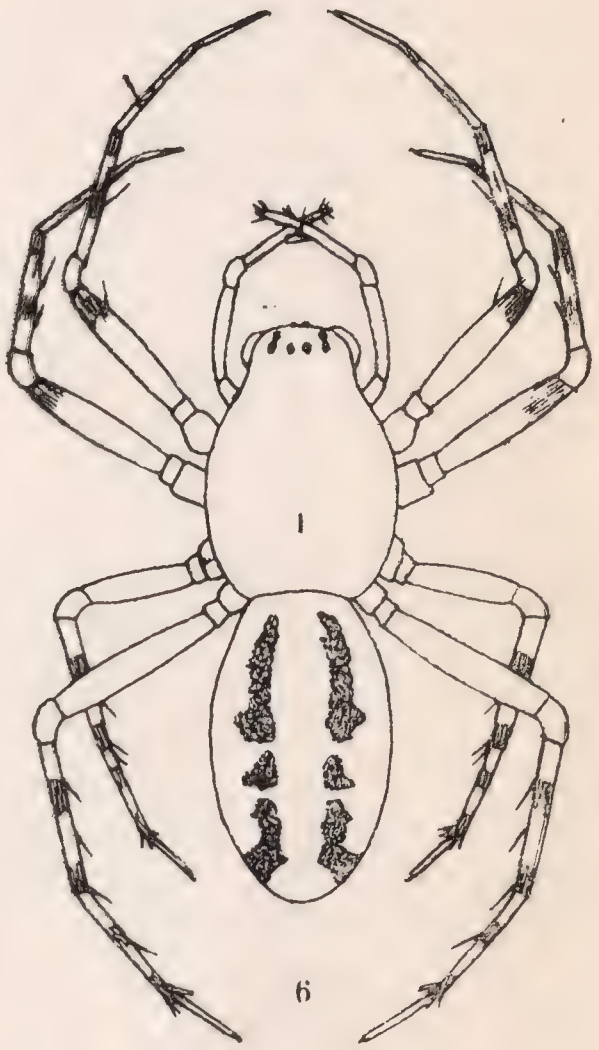

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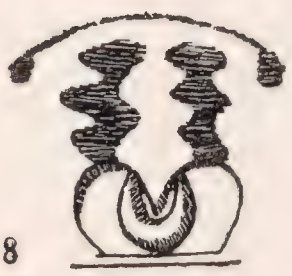

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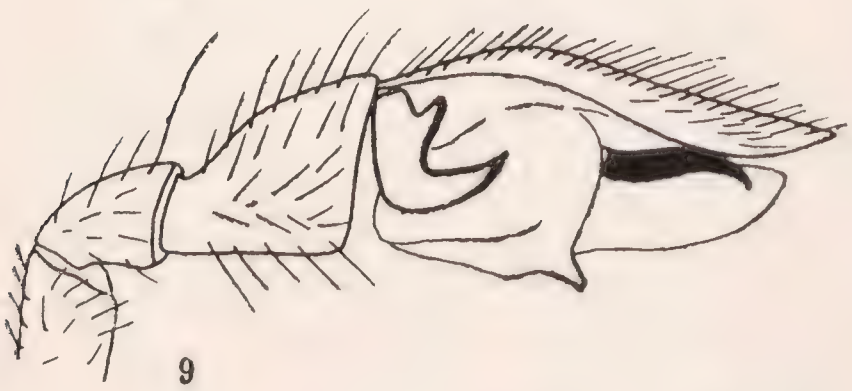

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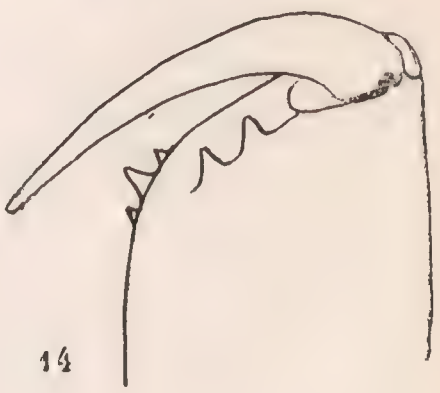

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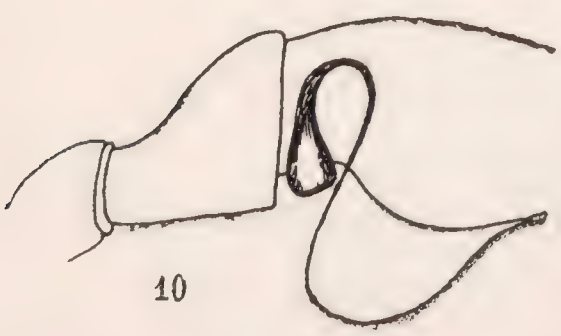

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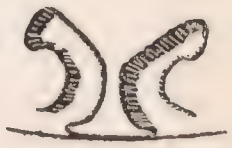


15

ORTHOPTERA AND DERMAPTERA FROM THE CHATHAM ISLANDS

By Averil M. Lysaght, Victoria College

I.—ORTHOPTERA.

The first thing that strikes one about the Orthoptera so far reported from the Chatham Islands is the scarcity of members of this group, which is represented by five species: three wetas, one cockroach and one phasmid. One is inclined to believe that other forms of this order are awaiting discovery there. None of the six known genera to which they belong is confined to the Islands, but one of the species is endemic.

The wetas comprise the following species:—*Gammaroparnops crassicruris* (Hutt), which is also found at Banks Peninsula, and *Pleioplectron serratum* Hutt; other species belonging to this genus occur in New Zealand, but *P. serratum* has been found only at the Chathams.

Onosandrus focalis (Hutt) was first described from a specimen from Central Otago.

The only known Phasmid was identified by Alfken as *Argosarchus horridus* (White). Till 1897 practically nothing was known about the insect fauna of the Chatham Islands, *G. crassicruris* being the only orthopterous insect recorded from there. Then J. J. Fougère made a collection containing, amongst those of other orders, a cockroach identified by Hutton as *Periplaneta undulivitta* (Walk), but which is probably identical with *Zonioploca brunni* (Alfk.).

In 1896-97 Dr. Schauinsland also made a collection of insects in the Chatham Islands, and obtained specimens of *Z. brunni* (Alfk.), *G. crassicruris* (Hutt), and *A. horridus* (White).

In 1903 *P. serratum* (Hutt) was found on Pitt Island by J. J. Fougère, who sent specimens to the Canterbury Museum. In a publication of Alfken's, dated 1904, the locality of one male specimen of *O. focalis* (Hutt) is given as the Chatham Islands.

In 1923-1924 further specimens of *G. crassicruris, P. serratum, Z. brunni,* were collected in the islands by Messrs. Archey, Lindsay and Cannon, and this appears to be the total extent of orthopterous insects ever obtained from there.

STENOPELMATIDAE.

With regard to the family Stenopelmatidae there is a certain amount of complication. Hutton divides it into two groups distinguished by several characteristics, chief amongst which is that of the possession of pads on the tarsi of the group Anostostominae, while he states that these pads are absent in the other group Doli-

chopodinae. On the other hand Alfken points out that *G. crassicruris* (Hutt) has distinct pads on the lower face of the tarsi, though Hutton placed it in the Dolichopodinae.

Alfken also declares that in *Gymnoplectron stephensiensis* (Alfk.) possessing laterally compressed tarsal joints there is the beginning of a pad formation at the tip of a single joint. He further suggests that the two groups should be classified according to the manner in which the femur and trochanter are joined—

"1.—Sohlentragende Arten.

"Die Hinterschenkel sind vorn in gerader Verlängerung mit den Hüften verbunden, am Grunde winkelig eingebuchtet oder schräg abgestützt. Die Innenseite ist fast auf ihrer ganzen Länge breit muldenförmig eingedrückt. Die Rinne an der Unterseite wird nach der Basis hin schwächer (und dient nicht zum Einlegen der Hinterschienen).

2.—Sohlenlose Arten.

"Die Hinterschenkel haben die Anheftungsstelle an den Hüften innen und sind am Grunde abgerundet (Der Chitinpanzer ist an der Basis stärker von aussen nach innen übergebogen). Die Innenseite ist nur an der Basis schwach ausgehohlt. Die Rinne an der Unterseite ist bis zum Grunde hin tief (und zur Aufnahme der Schienen geeignet).

"Bei der mir vorliegenden Art (*Gammaroparnops*) sind die Hinterschenkel am grunde nicht mit einem einspringenden Winkel versehen, sondern schräg abgestutzt. Dadurch nimmt sie eine ganz charakteristische Stellung unter den sohlen tragenden Arten ein. Bisher waren nur solche bekannt, bei denen die Schenkel mit einspringenden Winkel in die Hüften eingelenkt sind. Leider habe ich keine andere *Talitropsis*—Art auf die Tarsen und Hinterschenkelbildung hin untersuchen können."

This cannot be decided without careful examination of all known species, so for the present the position of *G. crassicruris* (Hutt) will remain an open question.

Genus GAMMAROPARNOPS Alfken.

(*Ergebnisse einer Reise nach dem Pacific* (*Schauinsland* 1896-97) *neue Orthopteren von Neu-Seeland und den Hawaiischen Inseln*).

"Corpus sat forte convexum. Fastigium profunde sulcatum. Antennae basi valde approximatae, corpore triplo sive quadruplo longiores. Elytra et alae desunt. Coxae anticae in latere externo spina acuta munitae. Femora antica et intermedia inermia. Femora postica crassa subtus sulcaca, apice spinulosa, basi oblique truncata, margine antica antice in coxas inserta. Tibiae anticae, calcaribus terminalibus exceptis, subtus spinis quattuor irregu-

laribus, non pariter dispositis, armatae foramina desunt. Tibiae intermediae spinis apicalibus supra una, subtus duabus, nec non subtus spinis duabus vel tribus. Tibiae posticae valde incrassatae, supra subplanae, subtus convexae, marginibus lateralibus spinis multis apicem versus acutis praeditis, apice calcaribus duobus. Tarsi depressi pulvillus praediti, articulo primo et secundoin apice spinis duabus longis.

"Feminae margo apicalis segmenti analis subrotundae excavata. Cerci segmenti anali longiores. Lamina subgenitalis longitudinaliter subcarinata, carina in medio lata tuberculata, margine laterali S-forme flexuosa, margine apicali profunde subrotundato incisa.

"Maris margo apicalis segmenti analis dorsalis valde triangulatim incisa. Lamina subgenitalis carinata, antice trituberculata. Styli parvi, incurvati."

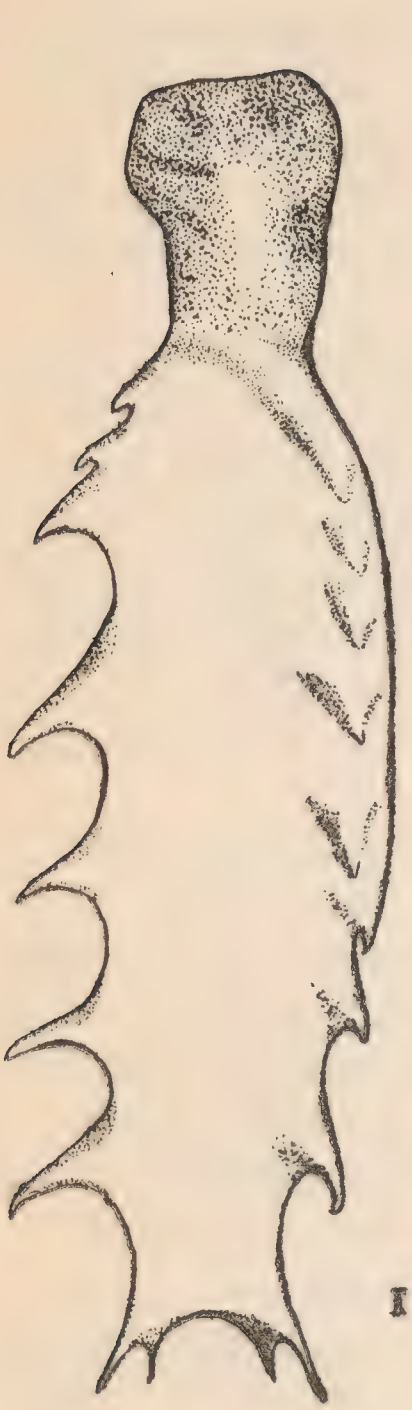
G. crassicruris (Hutt).

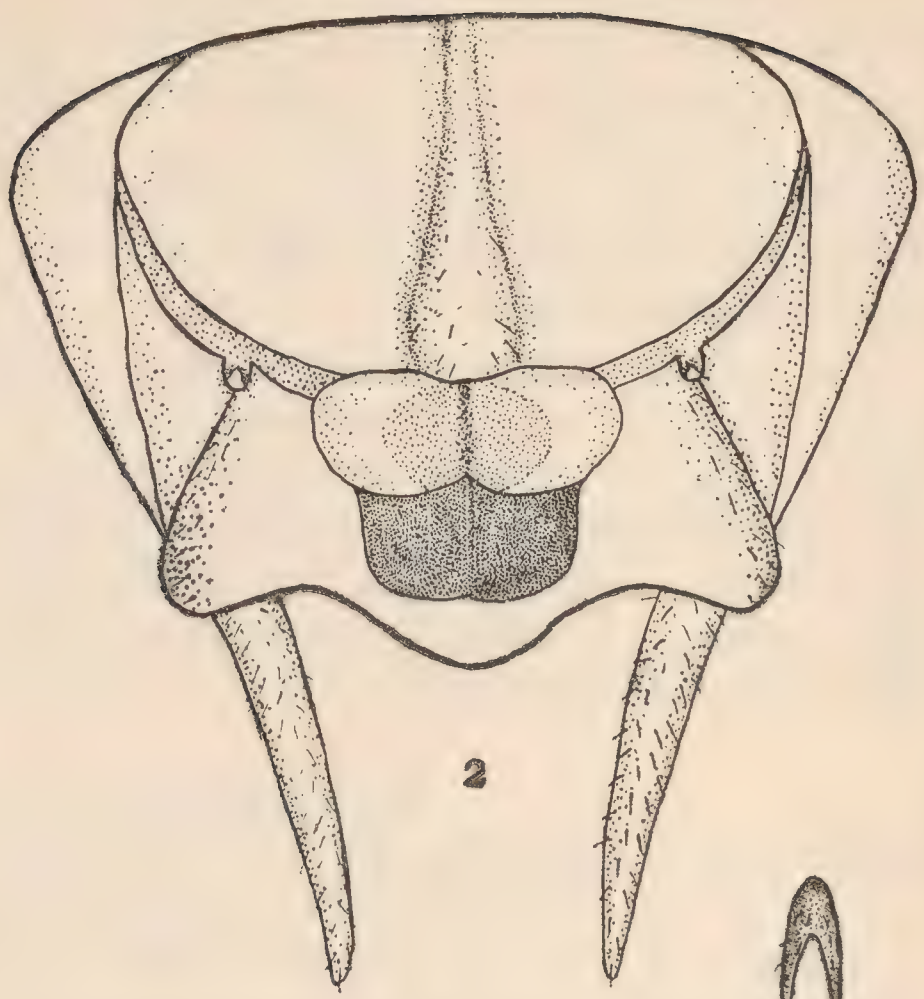
Talitropsis crassicruris Hutt, *Trans. N.Z. Ins. XXIX., 1896, p. 226, Plate XII., figs. 8, 8a.*

"Brunneotestaceus, superne brunneo et testaceo marmoratus, ab capite medium corporis versus longitudinaliter laete vittatus. Haec vitta in medio lata. Segmenta postica ad apicem infuscata, segmentum anale fuscum. Tibiae anticae et intermediae paulo brunneo marmoratae, femora postica apice, tibiae posticae et tarsi ferruginei.

Hab. Insulae chathamicae prope Nova Zealandia.

This description should be completed as follow:—"Body moderately strongly arched. Fastigium divided into two humps by a deep furrow narrowing behind. Antennae three to four times as long as the body, closely approximated at the bases, first joint strongly thickened, and on the inside produced into a blunt cone. Eyes large, bounded above by a straight line, below moderately pointed, facets lying closely. Pronotum in front straight without furrowed margin. Elytra and wings absent. Front coxae armed externally with a short spine. Front and mid femor unspined. Hind femora cut short obliquely at the base, united with the coxae in straight prolongation, strongly thickened, deeply furrowed below, margins of the furrow clothed with fine short hairs, its valley bare, and very finely cross-ringed, inside at the hip a sharp spine, which is only recognisable as a hump in the male. A sharp spine is present also at the tip outside, inside and at each side, and behind that on the outside a second smaller spine is often present. Fore tibiae with two apical spines below, and besides these, four irregular, unpaired, fixed spines. Hind tibia very strongly thickened, above almost flat with wavy surfaces and fine irregular grooves, below strongly arched, and rather thickly clad with fine short hairs of uniform length, the lateral margins carry, inside and out, rows of





FIGS. 1-4.

Fig. 1—4.—*Gammaroparnops crassicruris.*

1. Left hind tibia of male.
2. Supra-anal plate of male.
3. Supra-anal plate of female.
4. Hind tarsus of female.

spines, which become sharper from the base to the tip. At the tip there are two pairs of moderately sharp incurved spurs; they are somewhat brighter coloured than the spines, and the lower are slightly shorter than the upper. Tarsi provided with pads on the undersurface, the claws clad with short fine hairs below. The first two tarsal joints carry two long apical spines above, the third joint very short, the fourth almost as long as the first three together. Abdomen strongly arched, the base of the anal segment in the female deeply pressed in towards the back, the lateral margin with a sharp indentation, arched near the tip, provided with two small round foveoles, and in the middle of the margin of the tip flatly rounded.

The projecting margins with moderately long pubescens. Cerci considerably surpassing the end segment in length, thickly clad with short hairs of equal length, and furnished amongst these with longer, less numerous hairs of unequal length. Ovipositor four times as long at the cerci, at the tip finely indented below, at the sides almost square. The seventh abdominal segment furnished at the apical margin with a strong tubercle divided into two. The sub-genital plate with a blunt keel furnished medianly with a wide hump, the marginal border s-shaped, the apical border incised deeply and roundly.

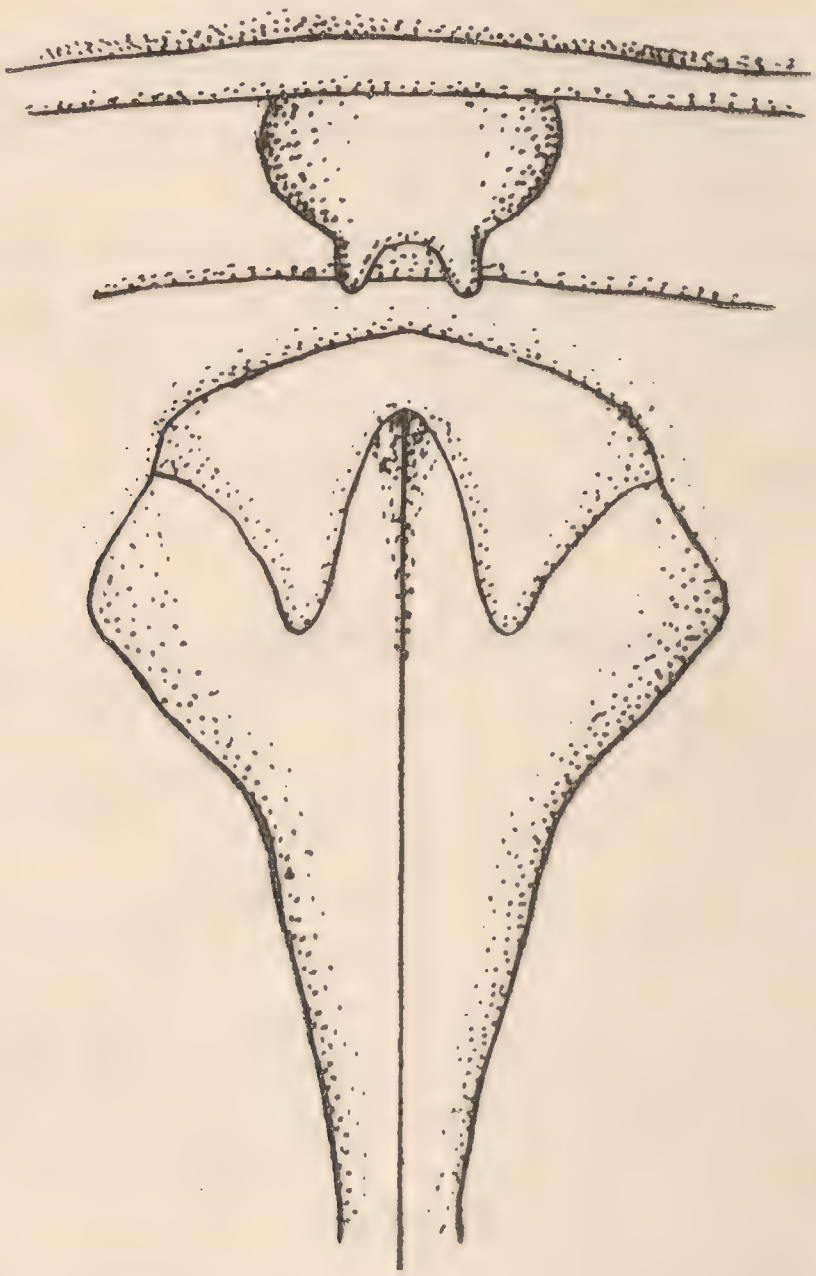


FIG. 5.

Fig. 5.—*Gammaroparnops crassicruris.*
Sub-genital plate and abdominal appendage of female.

In the male the anal segment resembles that of the female, but the apical margin is deeply, almost triangularly incised. Sub-genital plate in the middle bluntly keeled with three tubercles in front, and always furnished with little curved styles.

In colour this weta is testaceous brown, marbled dorsally with brown and testaceous, from the head to the middle of the body is a bright longitudinal streak, which broadens in the middle. Posterior

segments darker at the apex, anal segment dark. Fore and mid tibiae less marbled with brown ; apex of hind femora, hind tibiae and tarsi rust coloured." The above is a fairly literal translation of Alfken's description.

The number of spines on the hind tibiae of this insect varies extraordinarily, as the following table shows :—

Internal row.	External row.
8	3
7	7
7	6
7	3

The breadth of the hind tibiae is also variable. In specimens from Kaingaroa and Owenga this is especially noticeable, the limb in question being distinctly narrower.

The presence of an appendage on the seventh abdominal segment in the female is very interesting ; it has only been noted on two other species, both belonging to the genus Onosandrus. Its function is quite unknown ; there is no trace of it to be seen in the male, and it does not appear to be fully developed in the female until it is mature ; it does not seem likely, therefore, that it is ancestral.

Pleioplectron serratum Hutt.

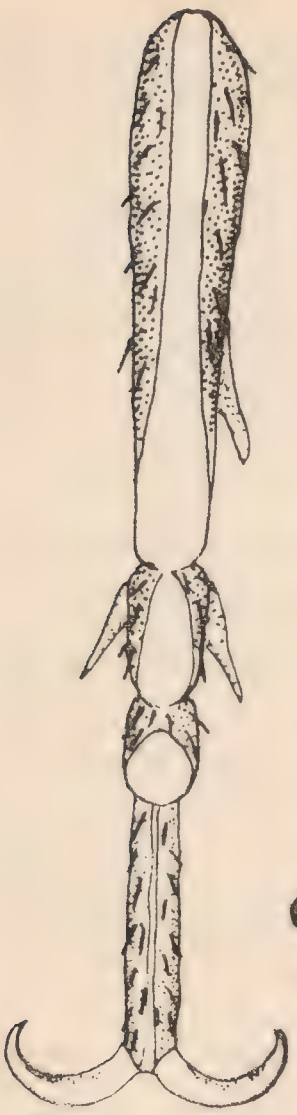
Hutton. *Trans. N.Z. Ins., Vol. XXXVI.*, 1904, *p.* 154.

Hutton places this genus in the group Dolichopodinae, but there are pads on the tarsi of this member of the genus as distinct as there are on those of *G. crassicruris* (Hutt).

The following points may be added to Hutton's description :—

The first two joints of the antennae are longer than broad, those following are broader than long till about one-third of the length from the tip, where they become longer in proportion. These terminal joints are clothed with fine short hairs, which are much more numerous here than on the first joints.

On examining Hutton's types, which are very dilapidated, and the specimens found on the recent expedition, there was found to be considerable variation with regard to some of the spines. On the fore tibia of the female there are two pairs of spines below and one unpaired one. In addition to these there is one pair of apical spines below, and a single apical spine at the side. On the mid tibia of the female there are three pairs of apical spines on the hind tibia and one and a pair of apical spines below, but none at the side. The number of spines on the hind tibia, which Hutton gives as sixteen to twenty, ranges from eighteen to twenty-eight on either margin in the females examined, and in the males from nineteen to twenty-five. In the female there are three pairs of apical spines, the hind tibia and one



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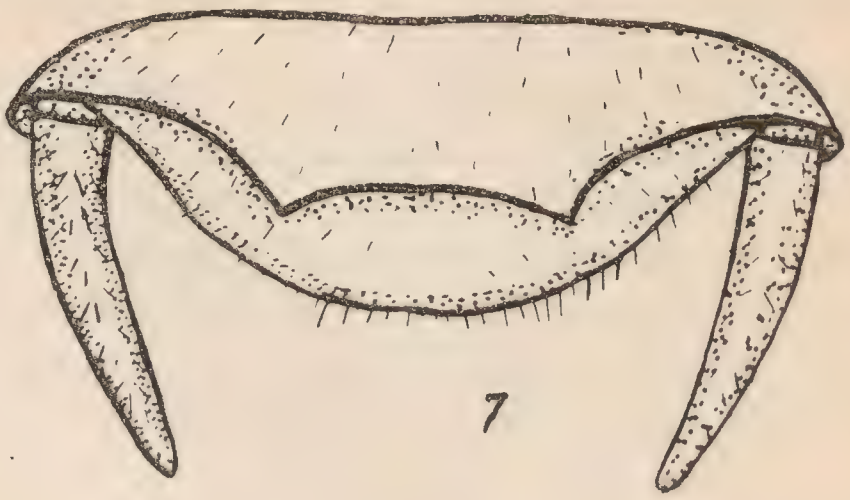

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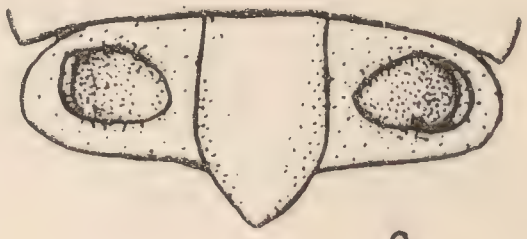

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FIGS. 6-8.

Fig. 6—8.—*Pleioplectron serratum.*

6. Hind tarsus of female.
7. Supra-anal plate of female.
8. Supra-genital plate of male.

very large unpaired spine on the inside ; the male has four pairs of apical spines on the hind tibia.

The hind femora, according to Hutton's description, have fifteen spines in each row below, but this is very variable. Two females had 15, 16; and 10, 13; and two males 22, 14 ; and 14. 14 respectively.

The specimen obtained during the last expedition is, unfortunately, too much shrivelled to allow of examination of the genitalia, but in other characters it resembles those described by Hutton. The type specimens were collected by J. J. Fougère on Pitt Island ; that mentioned above was taken at Mangere Island.

In " Zoologischer Jahrbücher, Syst Band XIX., 1904, Insecten fauna der Hawaiischen und Neuseelandischen Inseln," Alfken records the capture of a male on the road between Lake Wakatipu and Ben Lomond, and of a female at Elmsley Bay, and of another male from the Chatham Islands, unfortunately without giving any particulars. This appears to be the only record of its occurrence at the Chatham Islands, as it has not been found again by the recent expedition.

Zonioploca brunni (Alfken).

Platyzosteria brunni Alfken, *Ergebnisse einer Reise nach dem Pacific, Neue Orthopteren*, etc.
Zool. Jahr. Syst., Band XIX., 1904.
Insectenfauna der Hawaiischen und Neuseelandischen Inseln.

According to Kirby's "Synonymic Catalogue of Orthoptera," 1904, this bush cockroach belongs to the genus Zonioploca, established by Stäl [Bihang Svenska Akad ii. (13), p. 13 (1874)].

Alfken, in describing *Z. brunni*, declared that it was very close to *Zonioploca* (*Platyzosteria*) *undulivitta* (Walk).

I give here below Alfken's remarks on the differences between the two species, which he believes were once identical, but have become distinct owing to the different conditions prevailing at the Chatham Islands.

"*Z. brunni* strongly resembles *Z. undulivitta*, but differs in being of larger size; lobes of the elytra less broad, very much rounded laterally, in the female greatly so towards the apex; less small in the male; posterior margin much rounded; supra-anal plate less broad, posterior margin of which is much incised.

Length body, ♀ 13-14 mm., ♂ 10-12½ mm.

Length pronotum, ♀ 4 mm., ♂ 3½ mm.

In colouring almost entirely agreeing with *Z. undulivitta* (Walk.). This species, which measures only 12-13 mm., surpasses it more or less in size, but is to be distinguished from it in mediately through the irregular form of the elytra stumps, these are in *Z. undulivitta* broad, almost square, moderately bent at the sides, and in the female cut short at the posterior margin, where in the male they are feeblv rounded off.

In *Z. brunni*, in comparison, the elytra are narrower, and more strongly deflexed on the side; in the female tapering greatly behind, in the male much less strongly so; strongly rounded off at the posterior margin; but the supra-anal plate is in *Z. undulivitta* much broader, and in the posterior margin more weakly indented than in *Z. brunni*."

Specimens of this insect have been found on Mangere Island and the main one.

In Trans. N.Z. Institute, Vol. XXX., p. 160, 1898, Hutton records the occurrence of *Z. undulivitta* from the Chatham group; this is probably coincident with *Z. brunni*, which resembles it so closely in general aspect that it is not surprising that Hutton thought them identical.

Argosarchus spiniger (White).

Acanthoderus horridus and *A. spiniger* White. *Zool. Voy. "Erebus" and "Terror," Insects*, p. 24, pl. 5, fig. 4, 1846. *A. horridus* Westwood *Cat. Orthopterous insects in Brit. Mus.*, p. 49, 1859. Hutton *Cat., New Zealand Orthoptera*, p. 76, 1881.

Argosarchus horridus, Hutton *Trans. N.Z. Ins., vol. XXX.*, p. 165, 1898, and *vol. XXXI.*, p. 59, 1899.

A. spiniger (White), Alfken, *Ergebnisse einer Reise nach dem Pacific· Neue Orthopteren von Neu Seeland und den Hawaiischen Inseln*, 1901·

Alfken, discussing the female, points out that Brunner's designation of the Clitumnidae as having smooth cylindrical cerci fails for the two genera *Acanthoderus* (Gray) and *Argosarchus* (Hutt.). In the male of *Argosarchus spiniger* he says that they are hook-shaped, very wide at the base, tapering at the tip, and convex on the outside.

This species has not been found again this time; the only record there is of it from the Chatham Islands is by a female in the Canterbury Museum collection, collected probably by Mr. Fougère.

II.—DERMAPTERA.

Anisolabis littorea (White).

Forficula littorea White, *Voy. "Ereb." and "Terror." Insects, vol. II.*, p. 24, plate 6, fig. 4, 5, 1846. *F. littorea* Hutton, *Cat. of N.Z. Orthoptera*, 1881, p. 93.

The comparative length of the antennal joints is given by White as a specific character, but in this case it is not so, being common to other species. The metathorax is very slightly lobed in both the male and female, though wings are never developed.

In some specimens there is a transverse line anterior to the longitudinal line at the back of the head; it is most distinct in immature specimens. The forceps differ in the two sexes, those of the female are rather longer and less curved than those of the male, the supra-anal plates differ very slightly, the sub-genital plates are alike.

This insect appears to be as common in the Chathams as it is in this country. J. J. Fougère forwarded a specimen to Hutton in 1898 (Trans. N.Z. Ins., vol. XXX., p. 160, 1898), and during the recent expedition specimens were taken from Maunganui, Kaingaroa and Mangere Island, two males, six females, and two immature females comprising the collection. All these specimens are much darker than those of the main land, the body being completely dark brown.

In conclusion, the writer wishes to thank Mr. A. L. Tonnoir for the privilege of examining the materials which provided the substance of the above notes, and also to express her indebtedness to Mr. David Miller for much kind help and criticism.

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NEW ZEALAND DIXIDAE (DIPT.)

(Addition and Correction).

By A. L. Tonnoir, Assistant, Canterbury Museum.

Last year I created a new genus **Dixella** (*) to receive a peculiar form with reduced venation. It happened by an extraordinary coincidence, that, a few weeks before, Knab had created under the same name a new genus of Dixidae, a family which had remained monogeneric for nearly a century.

The two forms are, however, completely dissimilar, Knab's genus being characterised by the absence of *m-cu*.

Dixella Knab, having priority over mine, I propose to re-name **Neodixa**, the genus I have here described, as **Dixella.**

A further species of Dixa from the North Island, having come to my possession through Mr. T. R. Harris, I take here the opportunity to describe it, dedicating it to its discoverer.

Dixa harrisi sp. n.

Male—Head shining black, epistome and proboscis yellow, palpi and antennae brown, the latter much longer than the head and thorax together, the basal segments of the flagellum elongate and filiform.

Mesonotum dark orange, with three dull more or less fused broad dark stripes, the middle one shortened at the back, leaving a rather large orange area in front of the scutellum, which is dull brown as well as the postnotum ; pleurae shining black. Abdomen dull brown. Hypopygium with forked claspers carrying a few spines in the fork ; aedeagus with three pairs of spines, and the tergum with one pair of small forked spines (see fig. 1b, pl. XLIV.).

Legs : coxae yellow, femora yellowish, especially the posterior ones, all with a black tip, tibiae and tarsi brownish, hind tibiae yellow in the middle.

Wings with only one rather large brown spot placed on fRs and *r-m*, Cu2 margined with a slight brownish shadow. Venation : *r-m* placed on R4 + 5 beyond the fork of Rs at a distance from it about equal to its own length, the base of the stem of R2 + 3 very much curved upwards, forks of R2 + 3, and M at the same level. Halteres yellow.

Length of wing, 3 mm.

Type : Ohakune (T. R. Harris), III. 1923, in Canterbury Museum collection.

This species comes near *Dixa neozelandica* Tonn., from which it differs mainly in the more intensive and extensive brown spot on the wing, by the pleurae shining black and the structure of the hypopygium.

(*) These Records, vol. II., No. 4, 1924, p. 230.

NEW ZEALAND PIPUNCULIDAE (DIPT.)

By A. L. Tonnoir, Assistant, Canterbury Museum.

The representatives of this family, being scarce and inconspicuous, it is not surprising if they escaped being noticed in New Zealand by entomologists up to the present.

Besides the mere mention I made of it two years ago in an account on the Diptera of New Zealand (*) there is no record of this family existing in these Islands, although it is fairly well represented in Australia, especially in the sub-tropical and tropical part of that country.

With the exception of a couple of specimens collected in the North Island by Mr. T. Harris, and given to me for study by Mr. J. W. Campbell, there seem to be no other specimens in collections than those I collected myself. All were obtained by sweeping grass with the net either in the moderately thick bush or in the open tussock land.

In this material I recognise four species of the genus Pipunculus, which differ from each other by minor details of venation, colouration and structure of the hypopygium, such as is the case in palearctic species from which they do not differ in their general aspect.

It is interesting to note here that most of the small families of Diptera of New Zealand such as Dixidae, Thaumaleidae (Orphnophilidae), etc., do not show a peculiar aspect different from those of the other temperate regions of the world but that on the contrary, extensive families like Tipulidae, Mycetophilidae or Empidae exhibit a quite peculiar faunal facies.

The pipunculidae are characterised by a very large subspherical head, wider than the thorax, and composed almost completely of the two enormous eyes. Their venation is peculiar also by the shape of cell R5, which is nearly closed at the tip of the wing and by the cell Cu1 (so-called anal cell) being much elongated nearly to the wing's margin.

The affinities of this family are to be found with the Syrphidae and the Platypezidae ; the former is well represented in New Zealand, but the latter seems to be absent with the exception of an introduced species : *Microsania stigmaticalis* Zett.

The four New Zealand species of Pipunculus can be distinguished at follow :—

1—Wing without stigma ; *r-m* placed on the middle of the discoidal cell (1st M1) *P. novae-zelandiae*

Wing with a stigma ; *r-m* placed on the first third of the discoidal cell 2

(*) Bull. Soc. Ent. Belg. IV., 1923, p. 97.

2—3rd segment of costa equal to one-half of the 4th, the 5th more than twice at long at the 4th ; all the tibae completely orange. *P. deansi.*

3rd segment of costa about equal to the 4th, the 5th not twice as long as the 4th ; posterior tibae dark in the middle. 3

3—Large size ; one of the terminal lamellae of the hypopygium with a lateral process. *P. harrisi.*

Smaller size ; no lateral process on the terminal lamellae of the hypopygium. *P. arthurianus.*

Pipunculus novae-zelandiae sp. n.

Male.—Eyes touching on a rather short distance ; frons and face silvery when seen in certain positions ; vertex black somewhat shining ; occiput dull black, more greyish towards the lower part ; antennae dark, the third segment distinctly rostrate, and with slight silvery reflections, arista incrassate at the base ; proboscis and palpi dark.

Thorax dull black covered with a moderately conspicuous pruinosity.

Legs black, with greyish pruinosity ; knees orange, articulation of the tarsi somewhat ferrugineous ; inner and under side of hind femora shining ; hind tarsi dilated, especially the first segment.

Wings clear, without stigma ; 3rd costal segment short, the 4th only a little longer, and about four times smaller than the 5th ; *r-m* placed about the middle of the discal cell. Halteres orange.

Abdomen black, somewhat shining, with triangular grey spots on the sides of the segments.

Hypopygium relatively very large, ending in two falciform lamellae (see fig. 2).

Length of body and wing, 3mm.

Female.—Eyes well separated ; upper part of the frons dull grey ; 3rd segment of antennae more elongated and lighter coloured than in male. Legs as in male, but the hind tarsi not dilated. Abdomen somewhat more greyish. Distal part of the ovipositor's bulb shining black, its rostrum ferrugineous, and reaching the middle of the second abdominal segment.

Type : Cass, II. 1925, in Canterbury Museum collection.

Allotype : Cass, XI. 1924.

Paratypes : 3 males and 1 female, same locality and dates.
1 male, Wairakei, III., 1923.
1 male, Mt. Arthur (Nelson), 4,000 feet, XII. 1921.

Pipunculus arthurianus sp. n.

Male.—Eyes touching on a small distance only, ocellar triangle shining black, frons and face moderately silvery in certain positions ; palpi and proboscis dark ; occiput black, more greyish towards the lower part, antennae dark, the third joint rostrate, very slightly silvery when viewed in certain positions, its arista shining and incrassate at the base.

Thorax dull black, its pruinosity brownish on the disc of the mesonotum, more greyish on the sides ; humeri orange.

Legs : femora greyish black with orange tip, the hind ones with orange base, their inner and ventral sides shining ; tibiae mostly orange, somewhat infuscated in the middle. All the tarsi of normal shape, the first four segments orange, the last one dark.

Wing with a small brownish stigma ; the 3rd segment of costa equal to one-half of the 4th ; this one, two and one-half times smaller than the 5th ; *r-m* placed on the first third of the discoidal cell. Halteres dark orange. Abdomen velvety, dark greyish-brown, except on the posterior border and the sides of the segments, where it is lighter grey.

Hypopygium moderately large, not much shining, its structure according to fig. 3, the terminal lamellae squarely truncate.

Length of body, 3 mm., wing, $3\frac{1}{2}$ mm.

Type : Cass, 29, XI. 1924, in Canterbury Museum collection.

Pipunculus harrisi sp. n.

Male.—This species is very similar to the preceding one, from which it differs by the base of all the femora being narrowly yellow orange, and by its distinctly larger size, the length of body being 4 mm., and that of the wing, 5 mm. The venation differs by the 4th segment of the costa, being a little shorter than the 5th and the 3rd, also somewhat shorter than the 4th (12.15.18). The hypopygium as shown in fig. 5 has a completely different aspect, the terminal lamellae being triangular, and one of them having a lateral process ; the penis is long and curved.

Type : Ohakune (T. R. Harris) without date, in Canterbury Museum collection.

Paratype : one male Okakune (T. R. Harris), 20.XI. 1919.

Pipunculus deansi sp. n.

Male.—Similar to P. *arthurianus,* from which it differs by the eyes more touching, the third antennal segment more rostrate, the rostrum being equal to the basal part. Besides the tibiae are completely orange, and also the mouth parts. Wing with the 4th costal segment not larger than the third, and about half as long as the 5th.

Hypopygium as shown in fig. 4, the end lamellae. with obliquely truncated extremity.

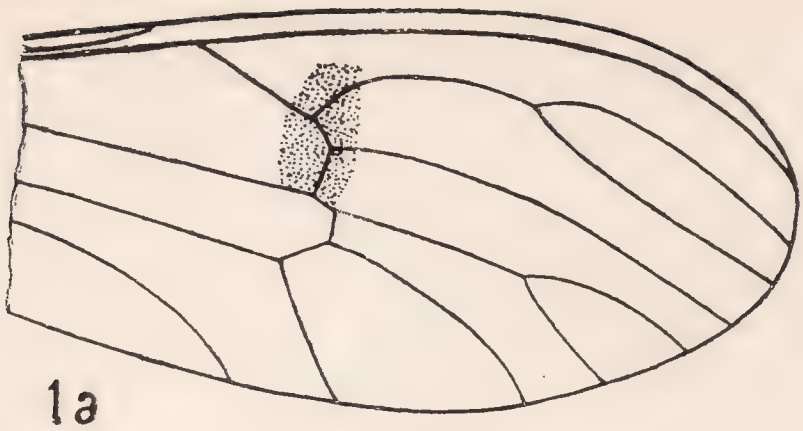
Length of body and wing, 3 mm.

Female.—A specimen of a different locality than the type is referred to this species on account of the completely orange mouth parts and tibiae, but the 5th segment of costa is relatively conspicously longer.

Type : Deans Bush (Riccarton), 21 XI. 1924.

Allotype : Aniseed Valley (Nelson), 1.XII. 1923.

(Both in Canterbury Museum collection).



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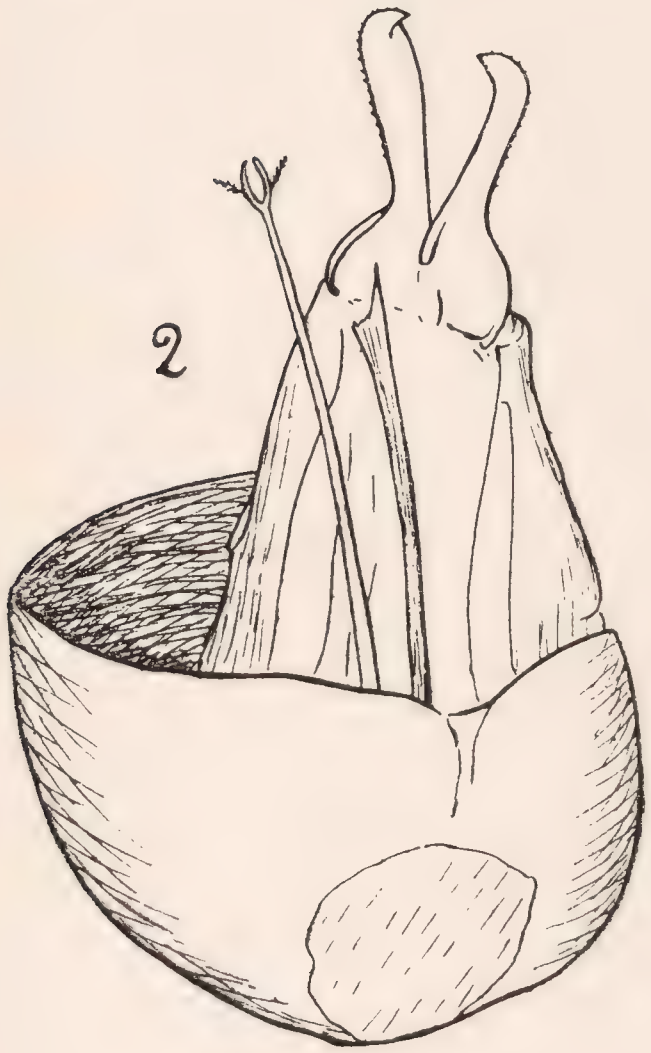

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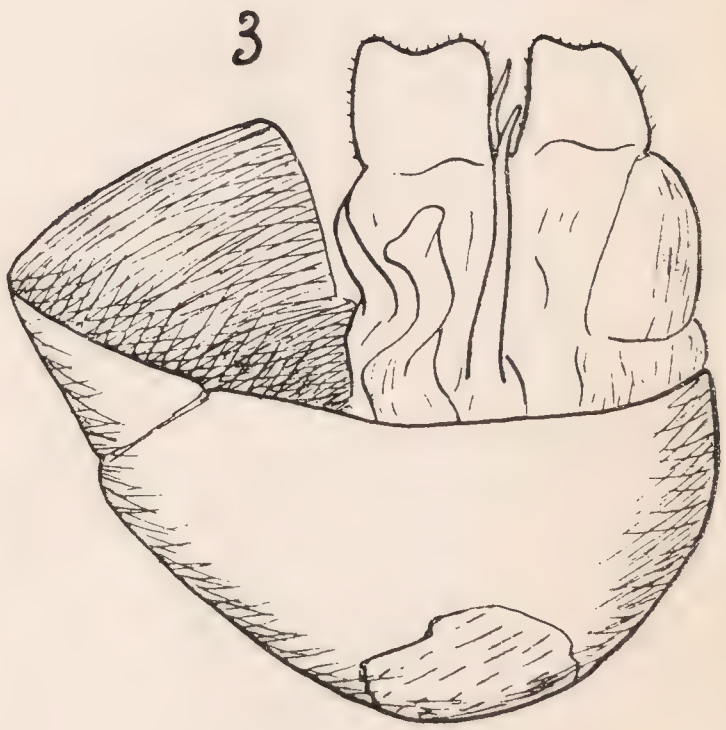

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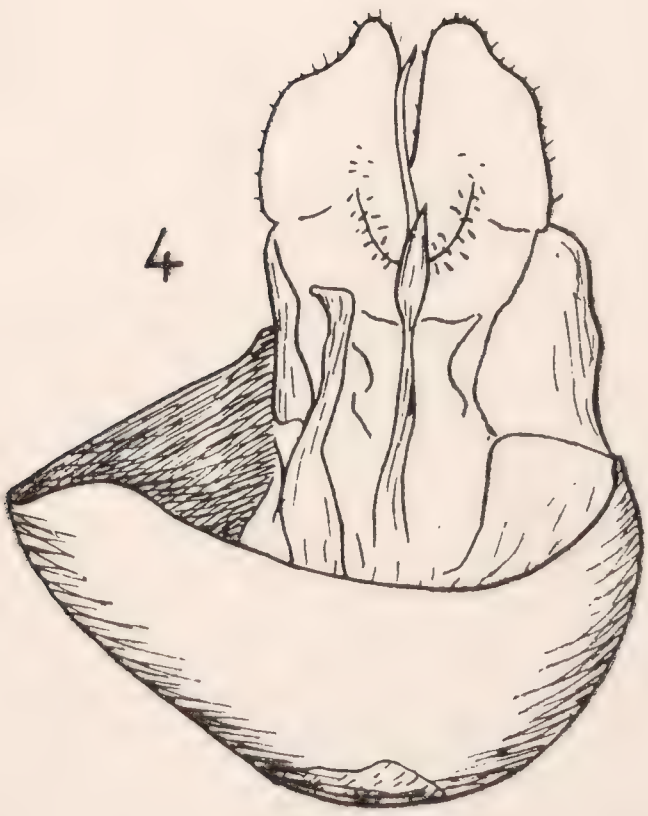

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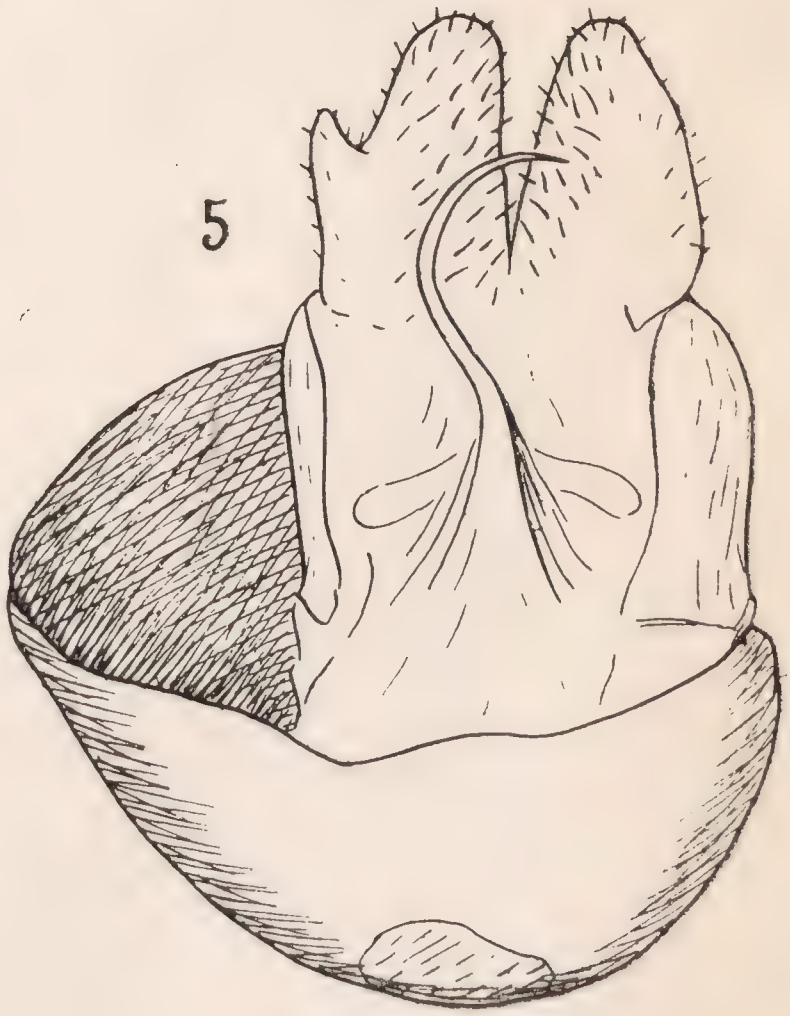

5

SOME AMPHIPODA AND ISOPODA FROM THE CHATHAM ISLANDS

By Chas. Chilton, M.A., D.Sc., etc., Professor of Biology, Canterbury College, New Zealand.

The number of Amphipoda and Isopoda collected at the Chatham Islands by Mr. G. E. Archey during December and January, 1923-1924, is small, and most of them are littoral or terrestrial forms. Attention was specially directed to these, as they were likely to be of more use than marine forms in determining the relation of the Chatham Island fauna to that of the mainland of New Zealand. Only one new species was obtained, all the others collected being forms well known from New Zealand. The occurrence of *Orchestia tucurauna* Müller, a South American species previously recorded from New Zealand, is interesting as showing that the species is widespread, and therefore helping to confirm the reference of the specimens from Picton and Kapiti Island to Müller's species. The connection with South America is supported by the distribution of some of the other species as set out in the list below.

In 1906 I recorded four species of Amphipoda from the Chatham Islands; they are all included in Mr. Archey's collection except the widespread pelagic form *Phronima sedentaria* Förskal (*P. novae zealandiae* Powell).

I also gave a list of nine Isopoda then known from the Chatham Islands. Of these five are included in Mr. Archey's collection now in the Canterbury Museum. The other four are species common in New Zealand.

List of Amphipoda.

Paramoera austrina (Bate).

Chilton, 1909, p. 625 (=*Moera fasciculata* Chilton, 1906, p. 271).

Okawa, in rock pools.

Distribution.—On all sub-antarctic shores.

Melita inaequistylis (Dana).

Chilton, 1909, p. 630 (=*M. tenuicornis*, Chilton, 1906, p. 271).

Okawa, in rock pools.

Distribution.—New Zealand, Australia, India, Ceylon, etc. Frequently found in brackish water.

Maera mastersii (Haswell).

Chilton, 1916, p. 367.

Mangere Island, in rock pools.

Distribution.—New Zealand and Australia.

Orchestia chiliensis M. Edwards.

Chilton, 1921, p. 2.
Mangere Island, under kelp, others on banks of small creek. C. Pattison, Maunganui ; The Horns ; Chatham Island.
Distribution.—New Zealand, Juan Fernandez, South America.

Orchestia tucurauna Müller.

Chilton, 1919, p. 379.
Maunganui ; South Slope, Mangere Island.
Distribution.—Chatham Islands, New Zealand, South America, South Brazil.

Talorchestia tumida G. M. Thomson.

Chilton, 1917, p. 296.
Distribution.—Chatham Islands and New Zealand.
Okawa Beach, in sand. "Pale bluish grey when alive." (Archey).

Parorchestia tenuis (Dana).

Chilton, 1909, p. 642, and 1911, p. 565.
Manukau, wet cliffs.
There are only two small specimens, both females and somewhat imperfect, so that the identification is not free from doubt.

Parorchestia sylvicola (Dana).

Chilton, 1911, p. 566.
Wharekauri, among bush on hill side ; Plateau Bush, Owenga.
This is the common terrestrial amphipod of New Zealand.
Distribution.—New Zealand, Chatham Islands, Kermadec Islands, Lord Howe Island. Closely allied to *P. hawaiensis* (Dana) of the Hawaiian Islands.

List of Isopoda.

Isocladus armatus (M. Edw.).

Tattersall, 1921, p. 217 (=*I. spiniger*, Chilton, 1906, p. 272).
Okawa, in rock pools.
Distribution.—Chatham Islands and New Zealand.

Exosphaeroma gigas (Leach).

Chilton, 1909, p. 652, Tattersall, 1921, p. 216.
Mangere Island, in rock pools.
Distribution.—Common on all Sub-antarctic shores.

Paravireia typicus Chilton, nov. gen. et sp.

Waipurua Creek.

This Isopod is described in a separate paper (see p. 321).

Iais pubescens (Dana).

Chilton, 1909, p. 649.

Okawa, in rock pools; on *Isocladus armatus*, found also on various other Sphaeromids.

Distribution.—All sub-antarctic shores.

Pentidotea lacustris (G. M. Thomson).

Collinge, 1916, p. 154 (=*Idotea lacustris*, Chilton, 1909, p. 658).

The Horns, Waipurua Creek;

Mangere Island, in small creek;

Hawaiki Creek, Owenga.

Distribution.—A brackish or fresh water form found in New Zealand and in South America (Patagonia).

Phalloniscus punctatus (G. M. Thomson).

Oniscus punctatus, Chilton, 1910, p. 288.

Maunganui;

Whangamarino, in bush, 700 feet above sea;

Mangere Island, East Bush and at summit, 937 feet above sea, and South Slope.

Owenga, Plateau Bush.

Distribution.—Chatham Islands, New Zealand, Auckland Islands, Tasmania and Australia.

Cubaris canaliculatus (Budde-Lund).

Chilton, 1910, p. 290 (=*Armadillo speciosus*, Chilton, 1906, p. 272).

Owenga, Plateau bush; Maunganui; The Point, Mangere Island; South Slope, Mangere Island; Summit, 937 feet, Mangere Island; Kaingaroa, in bush.

These specimens seem undoubtedly to belong to Budde-Lund's species with which *C. chathamensis* (Budde-Lund) is probably identical. The latter species was established by Budde-Lund for those specimens, which, in 1901, I had somewhat doubtfully identified with *Armadillo speciosus* Dana. If so, *C. canaliculatus* is the only species as yet recorded from the Chatham Islands, and its relationship to the species on the mainland of New Zealand requires working out.

Trichoniscus otakensis Chilton, 1910, p. 286.

In bush 700 feet, Whangamarino; Maunganui.

Philoscia sp.—Specimens apparently referable to this genus are present in the collection, but I hesitate to identify them specifically until the forms on the mainland of New Zealand have been re-investigated.

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A NEW GENUS OF ISOPODA (FAMILY SPHAEROMIDAE)

By Chas. Chilton, M.A., D.Sc., LL.D., etc., Rector and Professor of Biology, Canterbury College.

Among the Isopoda collected at the Chatham Islands by Mr. G. E. Archey in January, 1924, were five small specimens from "The Horns, Waipurua Creek," some of which were completely rolled up into a ball. At first these looked as if they belonged to *Cubaris* or an allied genus of Terrestrial Isopoda, for no legs or uropoda were visible, and, on unrolling the specimens, a still further resemblance was displayed, for the lower margins of the anterior segments of the peraeon were notched behind for the reception of the next posterior segment, as in many species of *Cubaris* and other genera. Further examination, however, showed that these resemblances were external and adaptive only, for the mouth parts, the antennae and the pleopoda proved to be quite different from those of any of the Oniscoidea, and to come nearest to those of the family Sphaeromidae. But it seemed difficult to fit the new form into any existing division of this family, for the pleon showed distinctly five segments all separate, or at least well marked off from one another, and there was no trace of the uropoda. Dissections and microslide preparations were made of one of the specimens, drawings prepared, and a preliminary description drawn up, when the work had to be put aside for other duties. In the interval my attention happened accidentally to be drawn to the genera *Caecosphaeroma* and *Vireia*, established by Dollfus about twenty-five years ago for blind subterranean species found in different places in Europe, and the resemblance of these forms, with highly convex bodies and vaulted pleons with uropoda vestigial or absent, to the Chatham Island specimens, was at once apparent. Re-examination confirmed the first impression of the relationship of the forms mentioned, and showed that the Chatham Island specimens must be placed near to *Caecosphaeroma* and *Vireia*, though they are found at a place so remote, differ in being of a dark colour and in the possession of well-developed eyes, and, much more important, have the pleon composed of five distinct segments instead of only two. I am therefore establishing a new genus *Paravireia* for the Chatham Island specimens, and suggest for it the following diagnosis. The relationship of the new genus to other Sphaeromidae and other general points connected therewith will be best discussed after the detailed description of the species has been given.

Genus **Paravireia** (novum).

Body very convex, capable of rolling into a ball. Peraeon of seven free segments, the seven peraeopoda short, sub-equal. Pleon of five separate segments, the first four short, the last (pleotelson)

large and broad. Uropoda absent. In other respects similar to *Vireia*.

Paravireia typicus sp. nov. (Plates 45-47, figs. 1-19).

With the characters of the genus.

Colour.—Whole dorsal surface dark coloured, almost black.

Length.—When unrolled, about 4 mm.

Locality.—In fresh water, The Horns, Waipurua Creek, Chatham Islands. Collected by G. E. Archey, January 25, 1924.

The species is probably a brackish or freshwater form. On being asked for particulars as to the locality, Mr. Archey replied that though he could not remember collecting this particular form, he was almost certain it was gathered, probably from under stones, in the water of the creek ; " although the spot was only a few hundred yards from the mouth the water was quite fresh, for the stream enters the sea over a waterfall about thirty feet high, but it is possible that rough weather would drive big waves into the stream itself, and thus the creatures could have got from the sea to the river at some time or other." Considering the affinities of the species, it is, however, probable that it is a permanent brackish or freshwater one, and it is highly desirable that it should be looked for in other fresh water streams of the Chatham Islands.

As there is only the one species it is not possible to distinguish specific characters from the generic. The following detailed description of a male specimen will, however, enable these to be drawn up should other species be discovered.

Body slightly narrowing posteriorly, very convex, with side portions of the segments almost vertical. Head much narrower than the peraeon, its front margin almost straight. Eyes well developed, round, situated posteriorly near the lateral margins. First peraeon segment longer than the others, which are sub-equal. First pleon segment short and without epimera, the next three sub-equal, short, epimera or side portions long, reaching to the same level as those of the peraeon ; last segment (pleotelson) large, broad, its anterior portion raised into a dome-like projection forming below a rounded concavity in which the pelopda rest, hind margin nearly straight.

The whole dorsal surface bears small scattered setae, each forked at the end, and with a fine cilium arising from the fork (see figs. 1, 2, 3, 4, 5).

In the whole animal it is difficult to see the connection of the peraeon epimera to their segments, but in a dissected male specimen mounted as microslides a straight line or suture is quite distinct in segments five, six and seven, though it cannot be made out in the anterior segments. The epimeral portion of segment one is

broadened below, and forked behind to receive the next segment when the animal is rolled into a ball, those of segments two and three are similarly forked and somewhat broadened, the remaining segments have the lateral portions narrow below and without fork (fig. 4).

The front margin of the head is nearly straight, with a slight concavity in the middle between thc bases of the first antennae. The epistome is rectangular, about twice as broad as long, its distal margin straight. The upper lip forms a semi-circle, the margin fringed with the characteristic short forked setae (fig. 7).

The first antenna (fig. 8) is slightly shorter than the second, its first peduncular segment lies close against the anterior margin of the head, the second joint is rather more than half the length of the first, the third about three-fourths that of the second, flagellum formed of one large joint (perhaps representing two), followed by two small joints, all three with a few setae.

In the second antenna (fig. 9) the last two joints of the peduncle are sub-equal and longer than the preceding, the flagellum rather shorter than the peduncle, and formed of seven joints, the first being much longer than the others, all with tufts of long setae.

The mouth parts are, on the whole, of normal structure, but are all rather elongated and slender.

The mandible (fig. 10) has a strong cutting end, molar process, and lacinia mobilis well developed, short palp three-jointed, not reaching to the end of the mandible.

Lower lip (fig. 11), with narrow inner lobes, extremity covered with fine setae.

First maxilla (fig. 12) with about ten stout setae at extremity of the outer lobe, inner lobe slender, with two plumose setae at the extremity, and a row of fine hairs on its outer margin.

Second maxilla (fig. 13) broad at base, inner lobe rather narrower than the outer, both rounded at the end, and covered with fine hairs, and, in addition, four stout setae on the inner and two on the outer.

Maxillipeds (fig. 14) with the second joint broad, the lobe arising from it long oblong, reaching nearly to the end of the palp, its extremity with seven plumose setae and some fine hairs. The palp shows five distinct joints progressively decreasing in size, their inner margins furnished with stout setae, but not produced into lobes.

The peraeopoda are short, slender, and sub-equal in length. In the first (fig. 15) the carpus is, as usual, quite short and almost triangular, in the others it is progressively longer (fig. 16). All the joints bear setae of varying size and character, the distribution of which will be best learnt from the figures.

In the first pleopod (fig. 17) the inner margin of the basal joint is armed with four pectinate setae, the endopod is a little more than

half as long as the exopod, much smaller, tapering distally, and bears three plumose setae at its extremity ; the exopod is broadly oval, and fringed with long plumose setae.

In the second pleopod (fig. 18) the basal joint and the exopod are similar to those of the first, but the endopod is branchial, and has its margins without setae. The male appendage reaches well beyond the exopod, and forms a slightly curved rod enlarged at the rounded end.

The third pleopod (fig. 19) is similar to the second without the male appendage, but the plumose seate on the margin of the exopod are much fewer in number. The fourth pleopod has the same structure as the third, but the exopod bears only three plumose setae.

The fifth pleopod was not made out with absolute certainty, but appears to consist of two oval branchial plates without transverse folds or thickened protuberances, and with the margins entirely free from setae.

There is no trace of the uropods.

Affinities of Paravireia.

Hansen (1905) has divided the Sphaeromidae into three subfamilies :—

1. *Limnoriinae,* in which the abdomen or pleon consists of six movable segments.
2. *Plakarthriinae,* in which the abdomen has all the segments fused together, the dorsal surface with two interrupted furrows as rudiments of division.
3. *Sphaerominae,* with the five anterior abdominal segments fused with one another, but generally showing transverse furrows, at most three and the posterior two broadly interrupted in the middle, as traces of division into segments.

The *Sphaerominae* contains the great majority of the Sphaeromidae, and is divided by Hansen into three groups, Hemibranchiatae, Eubranchiatae and Platybranchiae, mainly on the characters of the fourth and fifth pleopoda.

The genus *Vireia* and the allied *Caecosphaeroma* are placed by Hansen in the section Monolistrini of the Platybranchiatae. In this section the endopod of pleopod 1 is very narrow, both rami of pleopod 3, and of the following pairs are without marginal setae, the exopod of pleopod 3 unjointed, and the endopods of all three pairs opaque, respiratory, while the expopod is vitreous, and at least not so well adapted for respiration.

From the description which has been given of *Paravireia,* and particularly of its pleopoda, it must, I think, be concluded that this species should be placed under the Monolistrini, and near to *Vireia,*

which it so closely resembles in the complete absence of the uropoda. There are, however, differences even in the pleopoda, for the endopod of pleopod 1 is not "more than three times longer than broad," as in the others of the section, the exopod of pleopod 3 bears numerous marginal setae, and there are a few even in pleopod 4. A much more important point is, however, that *Paravireia* differs not only from the other Monolistrini, but also from all the members of the sub-family Sphaerominae by having the abdomen consisting of five separate segments. In discussing the structure of the abdomen in the Sphaeromidae Hansen points out that in the Sphaerominae it consists of two movable parts, the anterior one showing by its sutures that it represents four segments, and corresponds to the five free anterior segments in *Limnoria*, probably corresponding to the posterior four of these, the first having completely disappeared. The abdomen in *Paravireia* seems to confirm Hansen's conclusions, but instead of having the four segments fused they are all separate and apparently movable. The question therefore arises whether *Paravireia* should not be placed in a separate sub-family distinct from the Sphaerominae, or at least in a special section of that sub-family, the resemblance to the Monolistrini being due to convergence. It is true that the reduction of the uropoda may be merely an adaptation arising independently in different groups, but, on the other hand, it is only in the Monolistrini that the uropoda have been so nearly completely lost, and the general resemblance of the pleopoda of *Paravireia* to those of other Monolitrini is, I think, too great to be neglected. Moreover, the coalescence or otherwise of the segments of the pleon is perhaps not so important a character as it at first appears, and differences may occur among species closely allied. Thus in *Vireia burgunda* (Dollfus), and in *Caecosphaeroma virei* (Dollfus) the two parts of the abdomen are immovably fused with each other, while in *Vireia berica* (Fabiani) the two parts are movable, as in all the other Sphaerominae*.

I conclude, therefore, that *Paravireia* should be placed in the Monolistrini near to *Vireia*, and I look upon the section as composed of Isopoda that very early acquired the habit of rolling into a ball, and, as a result, have almost or completely lost the uropoda, while along with extreme specialisation in this point *Parvireia* retains the ancestral character of separate segments in the abdomen. The group is probably an ancient one that has survived owing to the

*This paragraph was written before I was able to consult Mons. E. G. Racovitza's very complete "Revision des Monolistrini" Archiv. Zool. Exper. et Gen. XLIX., p. 625, Biospeologica XIII., 1910. In it he states that *Vireia burgunda* and *V. berica* are not congeneric, the resemblances in the almost complete absence of the uropoda being due to convergence, and he places the first in the subgenus *Vireia* of *Caecosphaeroma*, and the second in the subgenus *Typhlosphaeroma* of *Monolistra*. Minute vestiges of the uropoda are, he says, present in both species. The Revision contains a very full account of the section *Monolistrini*, and of the origin of the forms included in it.

adoption of a fresh-water, and, in most cases, an underground mode of life. Certainly the existence of two genera so nearly allied as *Vireia* and *Paravireia* in localities so remote from each other as underground waters in Europe, and a fresh-water stream in the Chatham Islands, New Zealand, is a fact that commands special attention.

EXPLANATION OF PLATES.

Paravireia typicus Chilton, n. gen. et. sp.

All the figures are from a single male specimen.

Plate XLV.

Fig. 1—Side view of whole animal.
Fig. 2—Peraeon segments 1 and 2 with peraeopod 1 ; seen from in front with head removed.
Fig. 3—Peraeon segment 4 ; separated and seen from in front.
Fig. 4—Epimeral portions of first four peraeon segments ; seen from below.
Fig. 5—Pleon segments 1 and 2 ; one half shewn, flattened out.
Fig. 6—Pleon segments 2, 3, 4, with pleotelson.

Plate XLVI.

Fig. 7—Epistome and upper lip.
Fig. 8—Antenna 1.
Fig. 9—Antenna 2.
Fig. 10—Mandible.
Fig. 11—Lower lip.
Fig. 12—First maxilla.
Fig. 13—Second maxilla.
Fig. 14—Maxilliped.

Plate XLVII.

Fig. 15—First peraeopod.
Fig. 16—Seventh peraepod.
Fig. 17—First pleopod.
Fig. 18—Second pleopod.
Fig. 19—Third pleopod.

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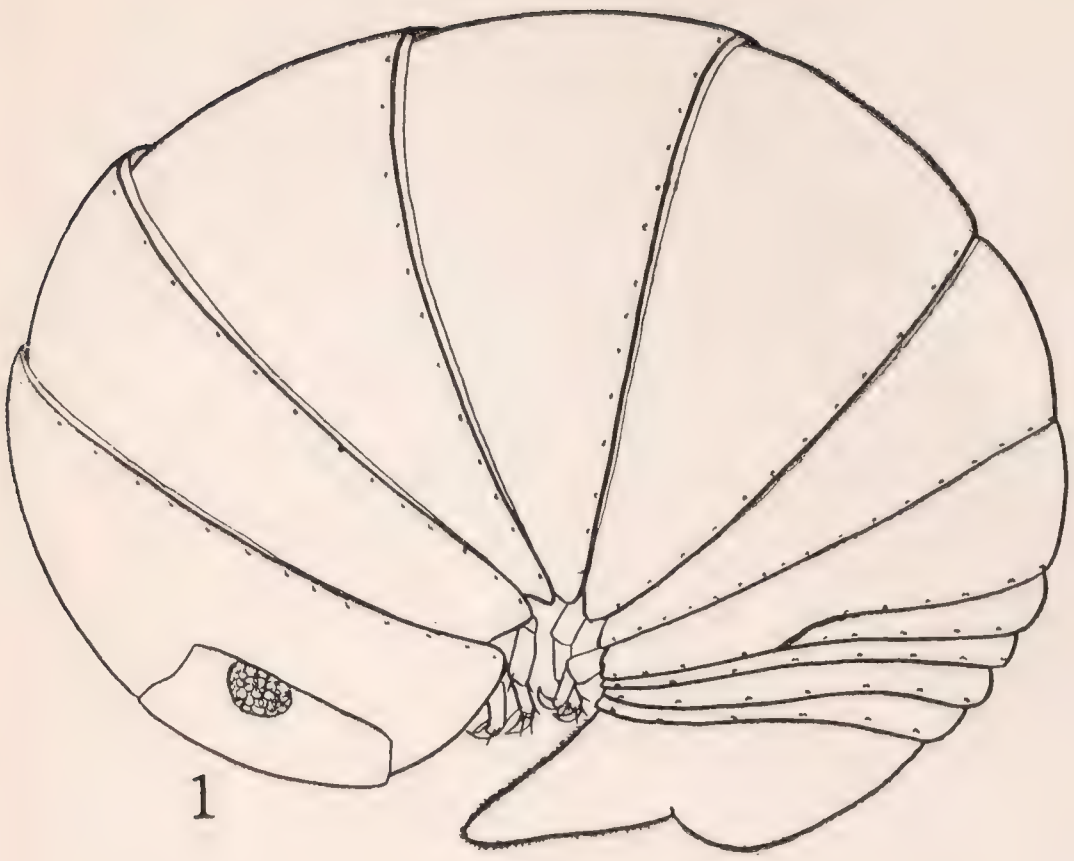

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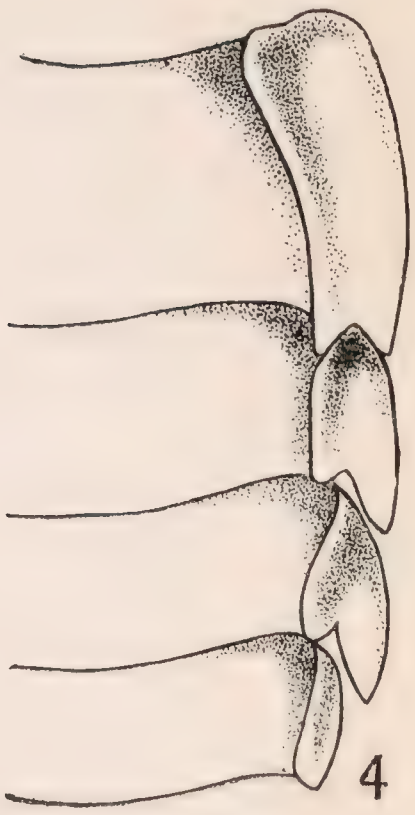

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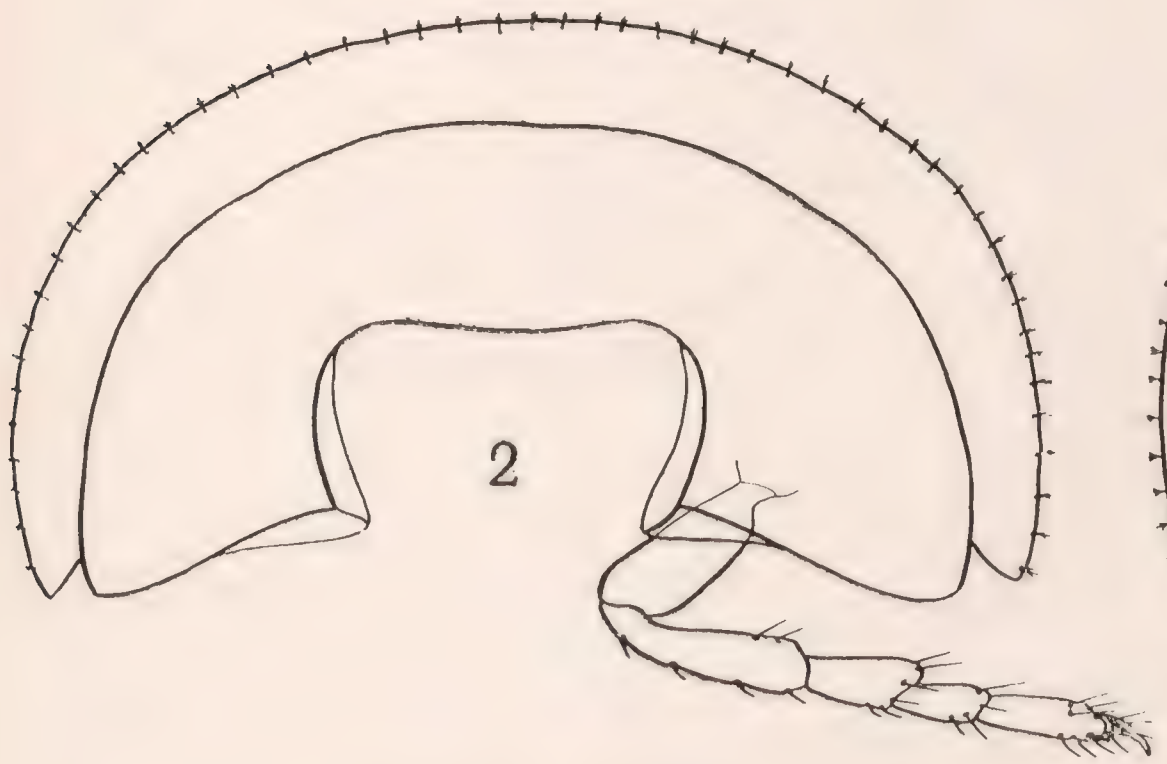

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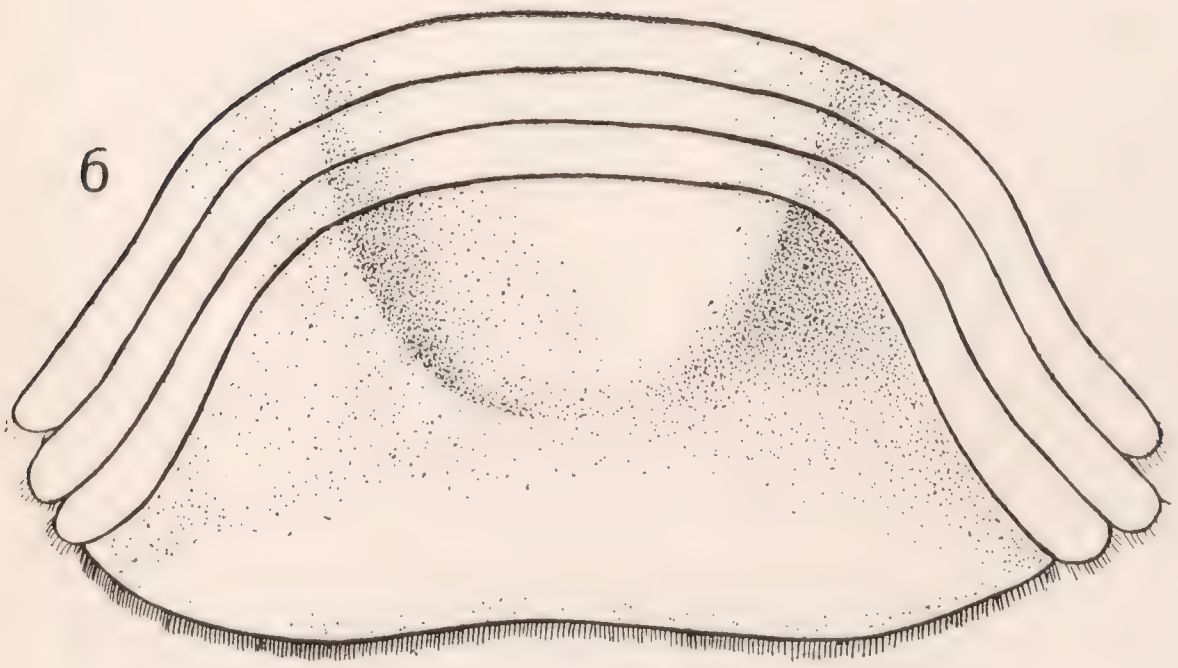

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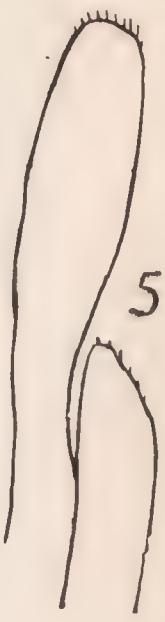

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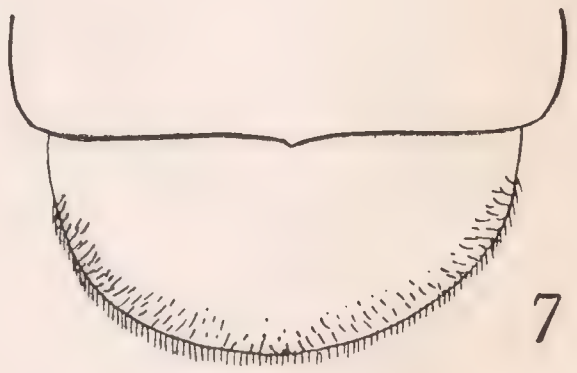

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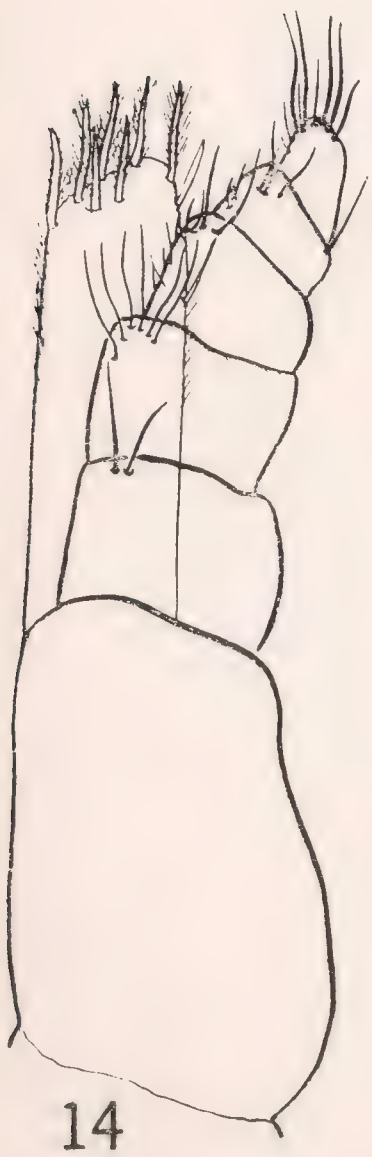

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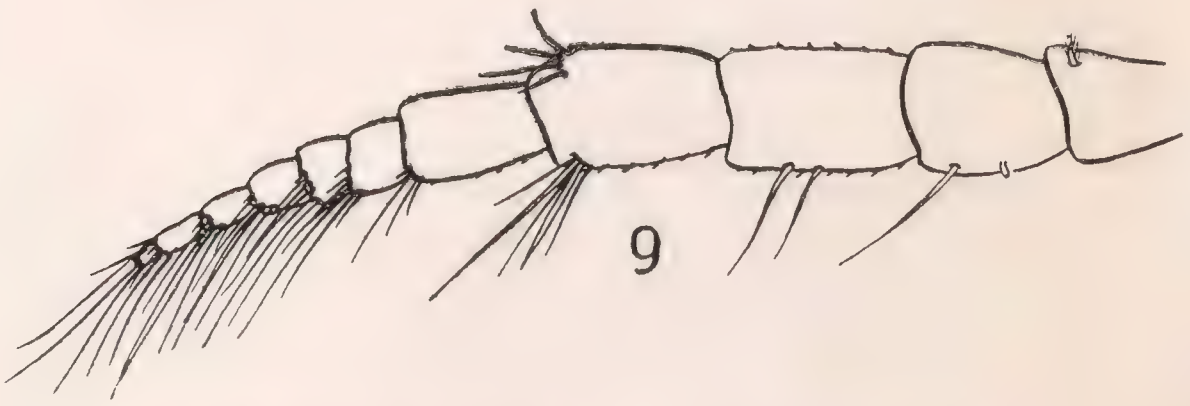

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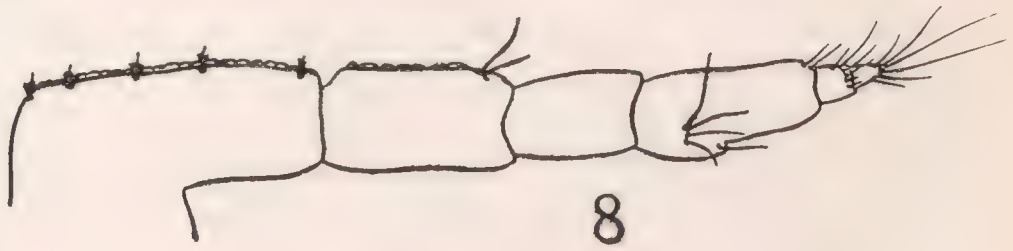

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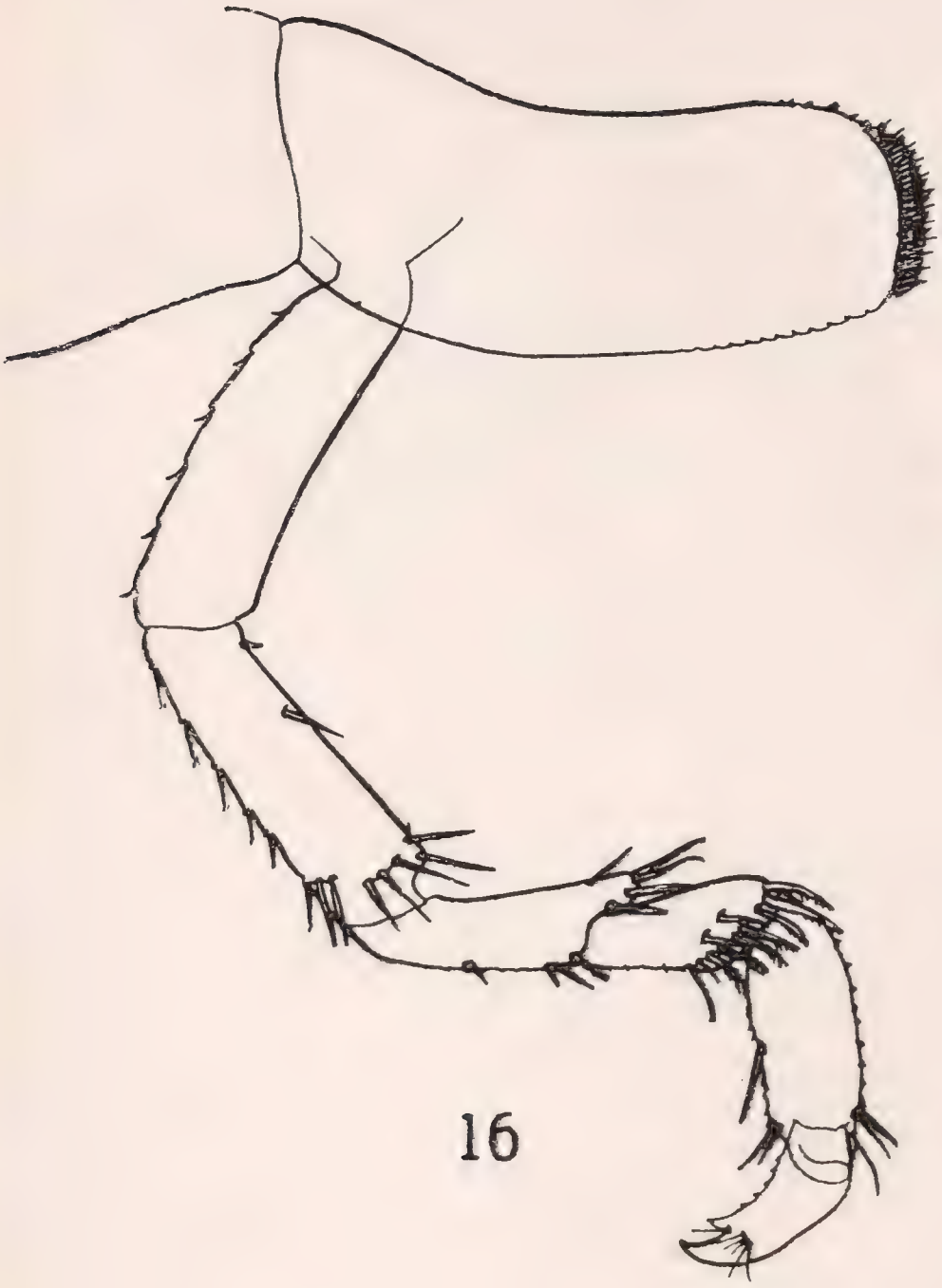

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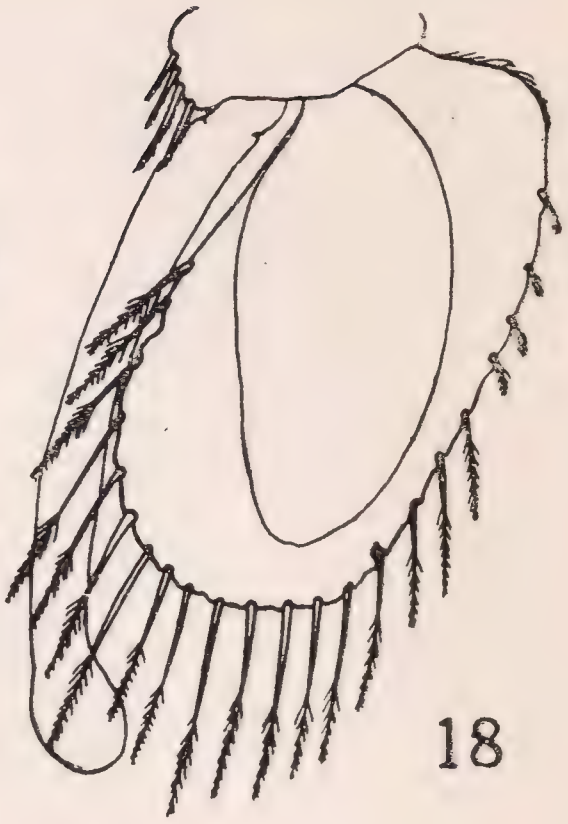

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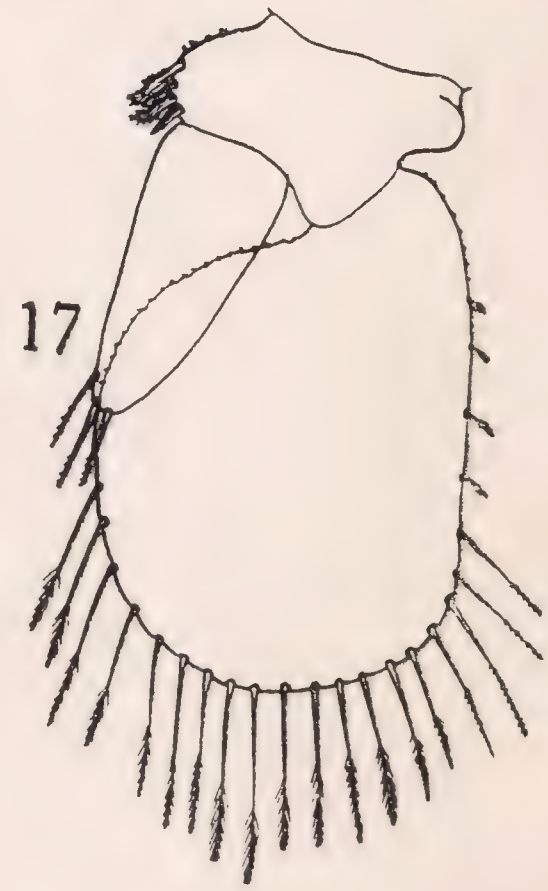

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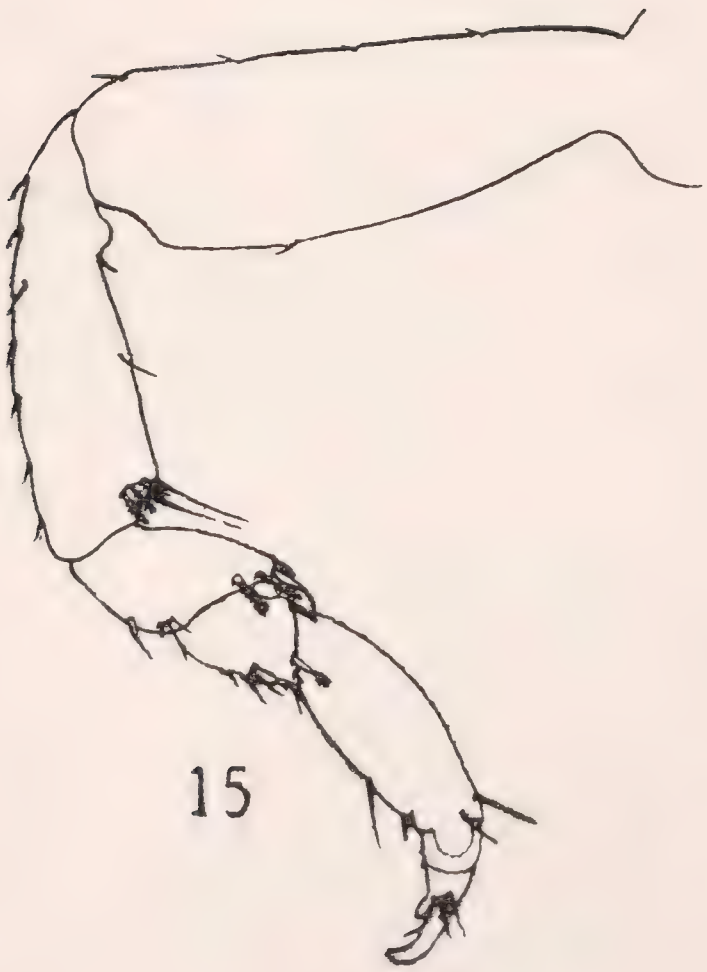

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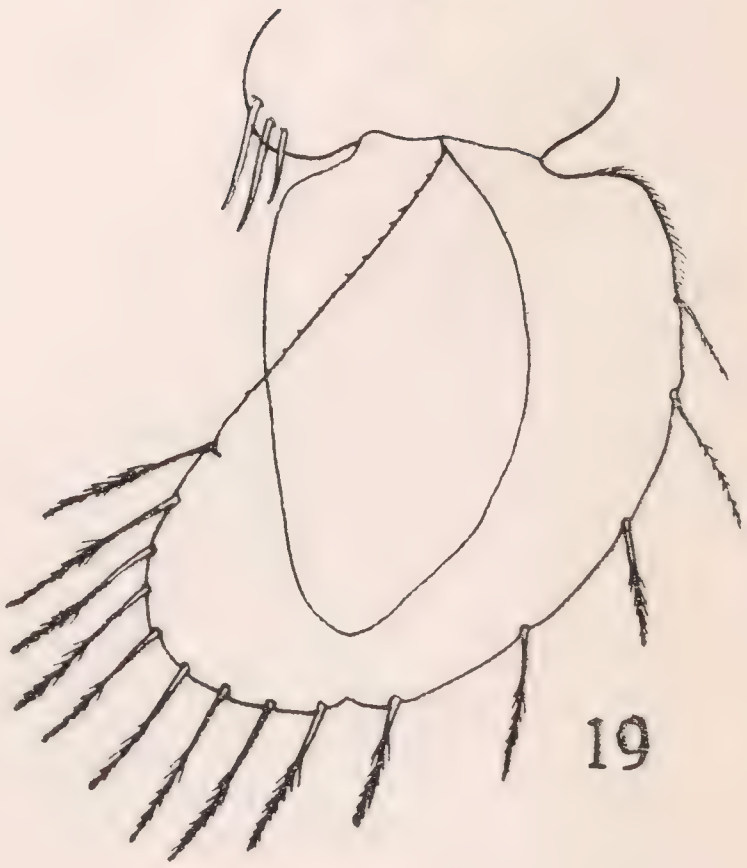

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NOTE ON SOME PEBBLES IN NEW ZEALAND COALS

By R. Speight, M.A., M.Sc., F.G.S., F.Am.G.S., Curator.

During the year Mr. H. J. S. Sylvester presented to the Museum a number of stones obtained from the middle of blocks of Paparoa and Kaitangata coals. These specimens serve to supplement specimens collected by myself or sent into the Museum on various occasions, and all of them suggest questions as to the occurrence of pebbles in coal-seams, which are, perhaps, of more than local interest. The problems to be considered may be divided into two heads—(1) the reason for the occurrence of such pebbles in the middle of coal seams ; and (2) the peculiar surface character of the specimens.

(1) *Their occurrence in Coal Seams.*

The great majority of the stones brought under my notice are composed of quartz, some are of greywacke, and I have seen in a coal seam at Malvern a rhyolite with chalcedonic banding such as might reasonably have come from a rhyolite in the vicinity of the seam. The pebbles range up to six inches in length. The largest weighed just over two pounds. They are always well rounded as if they had travelled far in water. The coal in the vicinity does not appear to be different from the general run of the variety characteristic of the seam. If the seam were a thin one, and inter-stratified with conglomerates, as some undoubtedly are, cf. Kaitangata, one could well understand why pebbles might be included, but when the beds associated with the seams are clays and sands, and conglomerates are hundreds of feet below them stratigraphically, this simple explanation of the presence of the pebbles hardly applies. If the stones had been carried by drift wood, and had been attached to the roots of the trees, there would have been some indication of this in the coal, perhaps in the texture of the coal, and specially an occurrence of shale owing to the incorporation of the clay usually accompanying the stones attached to the stumps. Now this apparently does not occur, so that such a method of transport may be looked on with distrust, though it may possibly account for the phenomenon.

2.—*Surface Character of the Stones.*

The surface character of the stones is their most striking feature. Apart from the rounding they show a surface which has certainly resulted from the attack of a solvent. The edges of the stones naturally show the effect best, but every part, even the interior of depressions, exhibit the same features as the more exposed portions. Weakly developed striations also occur at times, not only on the more exposed portions, but in those which would be protected

somewhat if they were due to rock movement. This explanation naturally occurs to one on making a casual inspection, but it is difficult to see why a somewhat soft substance like coal could produce such striations on a hard substance like quartz under normal conditions of the occurrence of coal without itself being completely crushed in the movement. In the cases I have seen there is no sign of crushing or of similar movement inside the coal itself. In fact, as a general rule—I am quite aware of exceptions—New Zealand coals have been subjected to a minimum of deformational movements, faulting being the only one which they have commonly experienced, and pebbles do occur where the coal has been very little disturbed since its consolidation after deposition. I cannot agree, therefore, that earth movements have been responsible for the striations.

There appears to be only one explanation left, viz., that some part of the rounding, the peculiar patination, and the striations are the result of the action of some solvent. The most probable source of the solvent must be the coal itself. The question naturally arises as to whether coal or the humic acids associated with it can exert a solvent action on quartz and greywacke when subjected to the moderate pressures obtaining in coal seams. I can find no support for this in the literature at my disposal, and shall be grateful to any reader for information concerning the possibility or impossibility of such action. It must be remembered that if the action is at all possible, unlimited time is at the disposal of the reacting substances, a condition which cannot be reproduced in any laboratory experiment.

I have considered another possibility, improbable though it may seem. The surface appearance of these stones closely resembles the Moa crop stones, of which we have a large number in the Museum, and this has suggested to me the possibility that they may have once been used for purposes of digestion by saurians, which inhabited the area in Cretaceous times. It is a well-known fact that crocodiles do swallow such stones, usually quartz pebbles, for this purpose, and the association of quartz pebbles with thc skeletons of plesiosaurs in such a position that they may well have been thus used when the animal was alive has been suggested by Seeley, and this has been supported by Williston (Water Reptiles Past and Present), pp. 92-4, 1914). It is a noteworthy fact that the chief reptiles inhabiting the Canterbury area in Cretaceous times, judging from the numbers of the skeletons found, belonged to the Plesiosaurs, notably the genus *Cimoliosaurus*, and it is conceivable that these stones took on their peculiar surface features in the stomach of such an animal. The special difficulty I have in advancing this suggestion with any confidence is that the stones are usually found singly. If they were in heaps, or if reptilian bones were closely associated with

them in the coal itself, there would be no objection to this explanation, but these conditions do not occur, and until the discrepancy is accounted for satisfactorily, the case rests on a very insecure foundation. I should be very glad, therefore, if any reader can put me in the way of securing authentic information as to the habits of crocodiles in this particular which would give support to the speculation, or discredit it entirely.

The occurrence of pebbles in the middle of coal seams is not confined to New Zealand, since in a personal communication Professor Richards, of Brisbane University, informs me that he has seen similar stones, with the same surface features in the middle of Jurassic coal seams in Queensland.

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